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MECHANICS OF PROLAPSE OF THE IRIS IN CATARACT OPERATIONS

CLINICAL OBSERVATIONS AND A METHOD OF PREVENTION

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It was my privilege to work with Sir Henry Holland in his ophthalmic clinic at Shikarpur, Sind, India, during the 1934 season. Several articles have been written about this unique clinic; therefore, it is unnecessary to describe it here. I should, however, like to pay tribute to Sir Henry Holland and his remarkable success at Shikarpur. Working far from other Europeans, and almost without facilities as they are known to the present day ophthalmologist, he and his fellow workers have developed one of the largest surgical ophthalmic clinics in the world. Such individual accomplishment is given to few men. To use his own words, "although poor in money I have been rich in opportunities." Others may add that he has used the "rich opportunities" uncommonly well. The honor of knighthood which was bestowed on him a few years ago was well deserved.

At Shikarpur there was an unusual opportunity to observe directly the mechanics of prolapse of the iris. The literature of late years contains little on the subject. The best description available seems to be the one by Ernst Fuchs,[1] and that is somewhat incomplete. I feel that a description of my observations in India may be of real value.[2]

Numerous patients came to the clinic at Shikarpur daily, seeking help for poor vision due to corneal leukomas, which were sequelae of trachoma and various types of ulcer, including smallpox. Optic iridectomy was performed on a great number of these patients. One routine step in this operation was the production of prolapse of the iris purposely. After a limbic incision was made with a Graefe knife, the knife was turned, and with the end of the handle, a quick little

1. Fuchs, E.: Text-Book of Ophthalmology, ed. 5, translated and revised by A. Duane, Philadelphia, J. B. Lippincott Company, 1917, p. 922.

2. This discussion is limited to prolapse caused by escape of aqueous through operative incisions at or near the limbus and does not deal with prolapse due to loss of vitreous or other contents of the eye.

push was made against the opposite side of the eye just posterior to the limbus. As a result, the iris would promptly herniate.

I took the opportunity to observe the exact behavior of the iris of some of these patients through a binocular loupe and to study the factors controlling the prolapse. The prolapse would not occur except under certain conditions. The whole process was observed repeatedly, both with quick and with slow pressure, and the various steps found to be about as follows: (1) collapse of the anterior chamber on incision as the aqueous in the chamber escaped; (2) formation of a water-tight seal between the iris and the cornea as the iris and lens pushed forward against the posterior surface of the latter; (3) imprisonment of the aqueous in the posterior chamber when escape through the pupil was cut off; (4) attempt of this aqueous to pass directly through the incision; (5) sliding of the iris on the posterior surface of the cornea toward the incision as the aqueous making its way through the wound forced the iris ahead of it (only that portion of the iris central to the line of incision moving into the wound, the part peripheral or posterior remaining stationary); (6) formation of a balloon as the iris progressively slid over the central lip of the wound, and (7) collapse of the balloon as the pupillary margin slid over the central lip, liberating the enclosed aqueous, the prolapsed iris remaining incarcerated between the lips of the wound. The various steps are shown in figure 1.

There was no tendency for the iris to move into the wound until the anterior chamber was completely collapsed. It was the aqueous in the posterior chamber which invariably caused the prolapse,[1] and that had to be imprisoned behind a valvelike seal between the iris and the cornea before the iris would move. Naturally, this seal was not very tight, and it did not dam back the aqueous for long. If given a little time, the aqueous in the posterior chamber would slowly pass through the pupil and seep out between the iris and the cornea. Unless pressure was made boldly as soon as the iris made contact with the cornea, or shortly thereafter, there would not be enough fluid left in the posterior chamber to effect a prolapse. Once the posterior chamber was empty, no reasonable amount of pressure or maneuvering would force out the iris.

If these observations were accurately made, then it follows that three factors are essential for the production of prolapse: (1) sudden loss of aqueous from the anterior chamber, (2) imprisonment of aqueous in the posterior chamber behind a seal formed by close contact of the iris against the posterior corneal surface and (3) continued pressure which forces this fluid out through the wound, ballooning the iris before it. If any of these factors can be controlled, prolapse will not occur.

Now to apply this to cataract operations; the lens, of course, is no longer in place after the operation, but the vitreous body takes its

place in pushing the iris against the cornea. Unless the chambers have refilled after operation, there can be no prolapse, and the chambers do not refill until the lips of the wound are sealed and are water tight. Consequently, the extreme care used in handling the patient's head in applying the dressing and in removing him from the operating table is not essential. The Vienese practice of allowing a patient to walk

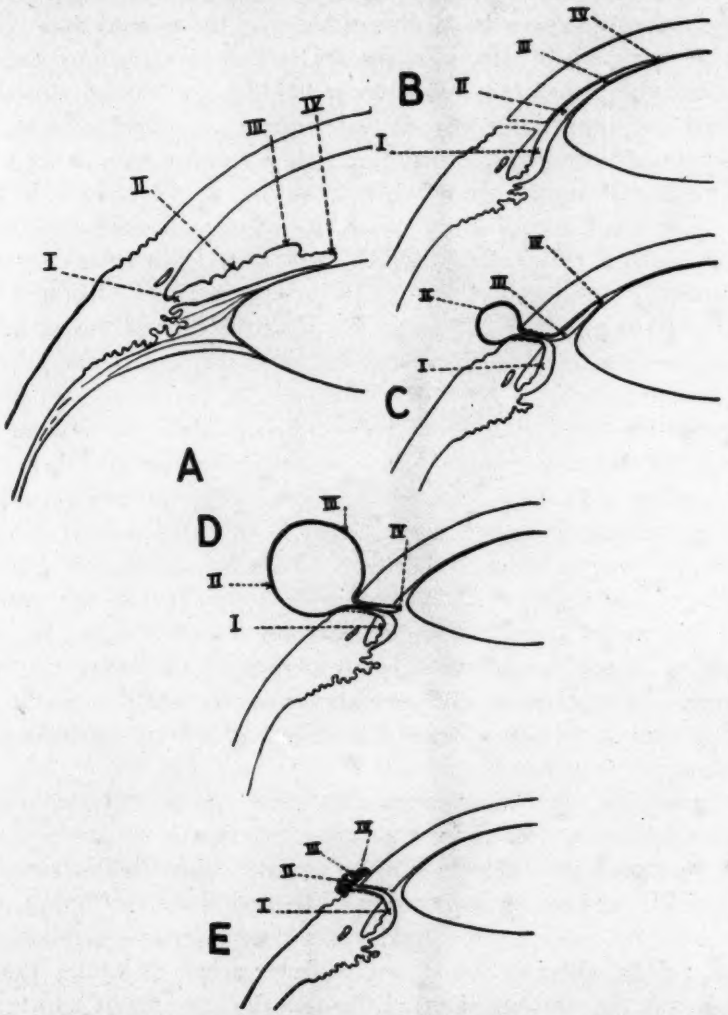

Fig. 1.—Movements of the iris during prolapse through a limbic incision. *A*, normal relation of the iris to the surrounding structures. Four points on the iris are marked to illustrate the changes in position of the iris during prolapse. *B*, collapse of the anterior chamber after incision. *C*, initial movement of the iris into the wound. *D*, full formation of the balloon. *E*, collapse of the balloon due to sliding of the pupillary margin (point IV) through the incision, allowing the contained aqueous to escape. (If prolapse develops postoperatively, the condition represented in *E* is much less distressing to the patient than that represented in either *C* or *D*.)

from the operating room to his bed is perfectly rational and not dangerous from this point of view. There is much more danger later in the day [3] or on the day after the operation, when the intraocular tension has returned to normal and the wound is closed by a fragile fibrinous seal, which may suddenly give way from any slight force applied to it.

Many procedures have been devised to keep the lips of the wound together, among them various types of conjunctival flaps. Unfortunately, the conjunctiva is so distensible that the wound may open and prolapse may occur subconjunctivally. This is common experience. Sclerocorneal sutures are effective in holding the wound closed at the point of the suture, but one or two sutures are insufficient to keep it tightly closed throughout its length. It is not uncommon to see a wound open near the angles, even when a suture at 12 o'clock is holding well. There is a record in the office files of my associate and me of one eye on which a full iridectomy was performed, two sutures were used and prolapse developed at one angle of the incision. Enough sutures (four or five) might be used to avoid any possibility of the wound opening, but, owing to the difficulty of inserting them, it is not practical to use so many.

Iridectomy and iridotomy are done to avoid the second factor, namely, imprisonment of the aqueous in the posterior chamber. Standard complete iridectomy performed at 12 o'clock, the incision extending from the pupillary margin to the root, is effective only if the wound should give way in the neighborhood of the 12 o'clock meridian, but if the lips of the wound should part at 10 or 2 o'clock, the underlying intact iris would cover the defect and be forced out by the aqueous behind it. These prolapses of one column or the other or both are also common experience. In general, it may be said that if the wound gives way at some point which can be covered from behind by intact iris, prolapse may occur.

At the clinic in Shikarpur, a few trials on patients who were to undergo full optic iridectomy demonstrated the effectiveness of a small iridotomy opening. It is possible to make a short limbic incision and then quickly and gently to make a tiny peripheral iridotomy opening without losing much of the fluid from the posterior chamber. After this was done, the iris would not prolapse when pressure was made, even though the aqueous squirted through the opening in a little stream several inches long. This maneuver was repeated a number of times, and in no case did the iris extrude.[4]

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3. According to Kronfeld and Lin (Tr. Am. Acad. Ophth. 42:262, 1937) the time required to refill the anterior chamber varies from ninety to one hundred and thirty-one minutes.

4. This little test was always made on that sector of the iris which was to be removed anyway in making the optic iridectomy.

It follows, of course, that the iridotomy opening had to coincide with the incision or the aqueous could not escape. If the hole was placed central to the incision, the iris would slide toward the incision until the hole entered the wound, when the aqueous would escape through it and the progress of the iris would cease. If it was placed peripheral to the incision, it would not prevent prolapse because the aqueous could not escape.

One iridotomy opening alone is not enough to prevent the imprisonment of aqueous with certainty, however, in the cases in which a long incision is made. Three alone are not enough either, because I have had prolapse occur at least once when three iridotomy openings have been used. One or two sclerocorneal sutures alone will not with

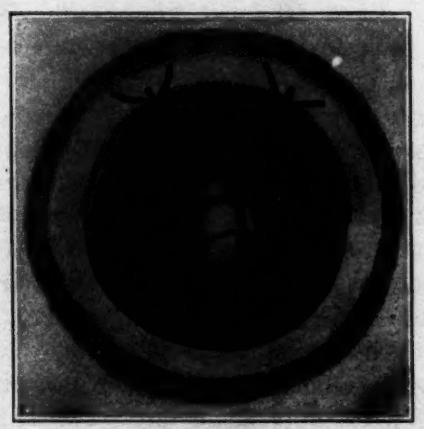

Fig. 2.—Appearance of the eye at the end of the intracapsular cataract extraction with a combination of two sutures and three peripheral iridotomy openings for the purpose of holding the incision closed and preventing prolapse of the iris.

certainty prevent the incision from opening and leaking, but a combination of the two sutures and three iridotomy openings affords a practical method which seems to prevent prolapse of the iris with reasonable certainty. The openings are placed between and on each side of the sutures (fig. 2).

Since my return from India my standard operation has become as follows: two sclerocorneal sutures radially placed at 10:30 and 1:30 o'clock; incision within the loops at the limbus without conjunctival flap; three tiny peripheral iridotomy openings at 10, 12 and 2 o'clock, and intracapsular removal of the lens through a round pupil (fig. 2).

Thus far, prolapse of the iris has not occurred in a single case in which the stitches were in place at the end of the operation. The sclerocorneal sutures are put in before the incision is made in a manner

similar to that used by Verhoeff [5] some years ago and do not penetrate to the anterior chamber.

The effectiveness of the method is further illustrated by several eyes in which the anterior chamber reformed, only to collapse again a day or two later. In all of these instances the iris remained in good position with a round, central pupil.

The series of cases in which this method has been used is unfortunately too small to establish alone the value of any method. It consists of only 48 cases, 1 in which both stitches were accidentally cut being omitted. In none was there any sign of prolapse or visible incarceration. Healing occurred in 46 of the 48 cases, with round, central pupils. In 1 of the remaining 2, the pupil was drawn upward somewhat, but no incarceration was visible externally. In the other the pupil was oval in the vertical direction, apparently because the pupillary margin at 12 o'clock had been folded backward between the ciliary body and the vitreous.

With the danger of prolapse of the iris removed, postoperative treatment may be simplified and improved. It becomes unnecessary for the patient to lie so exceedingly still in bed. Coughing, sneezing, vomiting or straining at stool do not carry the danger with them that they otherwise do. The patients in this series were allowed to sit up in bed the day after operation and in a chair on the second postoperative day. There seems to be no reason why such patients should not sit up immediately after the operation if they so desire. A full diet was given, copied as nearly as possible after that which the patient ordinarily ate at home, instead of the scanty liquid diet formerly prescribed. When a patient felt uncomfortable from constipation, an enema was given without hesitation. The result was that with reasonable freedom of action, their accustomed diet and lack of constipation, these elderly patients went through the experience of cataract operation much more happily and with far less distress and after-effects than did my patients formerly.

SUMMARY

Prolapse of the iris is due primarily to the imprisonment of the aqueous of the posterior chamber behind the iris when the cornea suddenly opens. Imprisonment of the aqueous occurs because the iris applies itself so closely against the posterior corneal surface about the breach in the wound that a relatively water-tight seal is formed. This seal may form in the presence of either a round or a keyhole pupil. An operative procedure has been developed and presented which can be expected to prevent most, if not all, prolapse of the iris and incarceration after cataract extraction.

5. Verhoeff, F. H.: Tr. Am. Ophth. Soc. **25**:48, 1927.

EFFICIENCY OF VARIOUS WOUND CLOSURES IN PREVENTION OF PROLAPSE OF THE IRIS AFTER CATARACT OPERATIONS

EXPERIMENTAL STUDY

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Methods of handling the limbic incision used in cataract operations have never been entirely satisfactory from the standpoint of prevention of postoperative gaping of the wound and herniation of the iris. Serious trouble is avoided in all but a small percentage of cases, but usually at the expense of the patient's comfort and well-being. In order to prevent these postoperative complications, the patient is commonly put on a scanty, constipating diet and immobilized more or less completely for upward of a week—a severe treatment for an elderly person. Various devices and methods of closure have been advocated, but despite these and despite enforced immobilization of the patient, gaping of the incision and prolapse of the iris continue to occur occasionally.

The crux of the matter seems to lie in the fact that during the process of healing the anterior chamber refills and intraocular tension returns before the wound is competent to withstand the pressure safely.

It seems to me that inevitably in every eye opened by a long limbic incision there must come a period of instability during healing. That period would extend between the time when the fragile fibrinous seal between the lips of the incision first becomes water tight and the time when this seal has become firm enough through organization to withstand reasonable pressure safely. The duration of this period of instability and the time of its occurrence are more or less immaterial. The material fact is that there comes such a period when the eye is in danger of more or less serious complications unless the incision is supported in some way which is independent of the healing process or unless the anterior and posterior chambers can collapse harmlessly.[1]

Many types of stitches and flaps have been devised and tried in order to prevent gaping and prolapse, but most have not been entirely successful, perhaps partly because the mechanics of the accident have not been fully appreciated.

This work was encouraged and assisted by a grant from Dr. D. L. Tilderquist.

1. Hilding, A. C.: Mechanics of Prolapse of the Iris in Cataract Operations: Clinical Observations and a Method of Prevention, Arch. Ophth., this issue, p. 171.

EXPERIMENTAL WORK

Last winter I undertook a series of experiments on animal eyes designed to test the efficiency of various methods of wound closure, including a method that has been used by me since making the observations on the mechanics of prolapse of the iris in India.[1] The eyes of oxen which had been enucleated immediately after the animals were killed were used for the tests.

Essentially the experiments consisted of a series of measurements of the intraocular pressure necessary to cause prolapse of the iris through limbic incisions under various conditions. Three hundred and eighty-five controlled prolapses with measurements of pressure were made on 26 eyes and are here recorded and analyzed. In addition, there were probably some 200 prolapses in another 12 or 15 eyes which were used in making motion pictures of the experiments later. These have not been recorded except on the film, but the results were essentially the same as in those here given.

The eyes were all enucleated with the conjunctiva practically intact and much of the orbital fat and extraocular muscles attached. In preparing them the conjunctiva was retained, but other extraneous tissues were removed. The vitreous and lens were removed through an incision across the posterior pole which was 25 or 30 mm. long, and the vitreous chamber was gently washed in running water. It was found necessary to refill the vitreous chamber at least partially in order to keep the iris in approximately normal position during the tests. If the iris fell or folded back into the empty vitreous cavity during the experiments, it sometimes failed to make contact with the cornea, in which case there usually would be no prolapse.

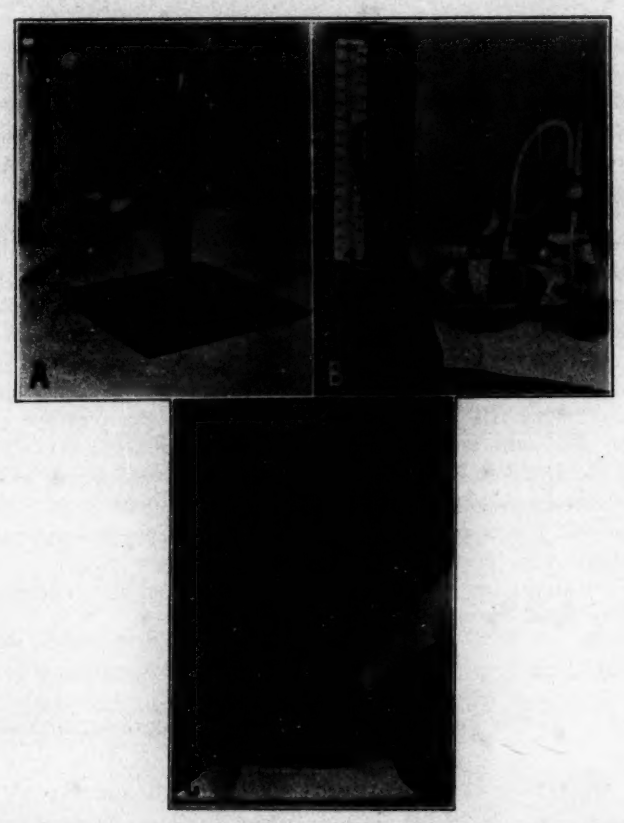
The eyes fall into three groups according to the methods of preparation:

Group 1 includes 13 eyes. In these eyes the incision was made in the cornea just at the attachment of the conjunctiva. A conjunctival flap was prepared by cutting the attachment of the conjunctiva to the cornea, adjacent to and for the full length of the corneal incision. The flap thus formed was stretched forward across the incision and stitched by mattress sutures to the cornea, thus covering the incision completely. The vitreous cavity was partially filled with cotton. Each eye was mounted on the clamp and through the clamp connected to a flask containing a large volume of saline solution which could be forced through the eye (*A* and *B* of the accompanying illustration).

Group 2 includes 5 eyes which were prepared somewhat differently. The conjunctiva was not incised. Instead, it was pulled forward and dissected free from the sclera in that sector in which the incision was to be made. The incision was placed right at the limbus in such a manner as to lie completely subconjunctival when the flap was replaced on the sclera. Before the incision was made, 3 cc. of air was injected into the anterior chamber in order to force the iris and lens back away from the line of incision. The vitreous chamber was partially filled with molten wax instead of cotton. As in group 1, the eyes were connected to the flask containing (for practical purposes) an unlimited amount of fluid.

Group 3 includes 8 eyes. With the exception of 1 eye, all of them were prepared the same as those in group 2. However, instead of the eyes being connected to the flask and hence to an unlimited amount of fluid, they were connected directly to the manometer and repeatedly filled with saline solution by injection through a hypodermic needle. The fluid was limited to what each eye could contain, thus simulating clinical conditions to a degree.

The clamp on which the eyes were fastened for the tests is pictured in *A* of the illustration. It consists essentially of two short curved blades mounted on a threaded metal tube. The front blade is soldered to the tube at its front end. The other blade is loose and can be forced firmly against the fixed blade by means of a winged nut. The tube is mounted on a stand as illustrated. When an eye is to be tested, the front blade is slipped through the incision across the posterior pole, and the loose blade is forced against it, thus covering the incision and clamping the sclera tightly between the two blades. The other end of the metal tube is connected by a rubber tube to a flask containing physiologic solution



A, clamp on which eyes were mounted for the experiments. The stem of the clamp is a tube and is connected with a manometer, as in *B*. *B*, eye mounted on the clamp and connected with the manometer and a flask of saline solution. *C*, eye connected directly to the manometer for the experiments in which pressure was made on the cornea (group 3).

of sodium chloride. The flask in turn is connected to a glass Y tube, one arm of which connects with a manometer and the other to a hand bulb, as in *B* of the illustration. As pressure is made on the bulb, saline solution is forced from the flask into the eye under pressure, which is indicated on the manometer. An ordinary clinical blood pressure instrument was used for a manometer in the earlier experiments. When it was found that pressures higher than could be measured on this instrument were encountered, a simple U tube manometer was made, as in *C* of the illustration, and used for all subsequent tests.

The limbic incision was always made before removal of the lens and vitreous and was usually 15 mm. in length. This was found to be a good length for the tests. The incision was placed parallel to the long axis of the the pupil. It was found that it could be made without injury to the iris, even when completely subconjunctival, if 3 cc. of air was first injected into the anterior chamber. The air bubble forced the lens and iris well back of the line of the incision.

Four different methods of wound closure were tested: (*a*) a simple incision without sutures or reenforcements of any kind but simply held closed by the resiliency of the corneal tissue; (*b*) an incision covered by various types of conjunctival flaps; (*c*) an incision closed by one sclerocorneal suture placed directly through the lips of the incision about the middle, and (*d*) an incision the same as the preceding one with the addition of a peripheral iridotomy opening made in that portion of the iris which prolapsed most easily. In the tables these four operative procedures are referred to as a, b, c and d, and the results in each are listed in columns captioned by the same letters. In some instances the data in column b are subdivided because various types of conjunctival flaps were used.

The preparations were mounted and connected to the fluid system and manometer, as in *A* and *B* of the illustration.

In making the tests, the operator observed the action of the iris as he gradually raised the pressure in the system by squeezing the hand bulb. An assistant watched the manometer and recorded the pressure readings at which complete prolapse occurred. Each eye was tested under all four surgical procedures, because it was soon found that there were such great individual variations that results were directly comparable only when all procedures were tested on a single eye. "Complete prolapse of the iris" was arbitrarily taken to mean prolapse of the entire width of the iris with escape of fluid past the pupillary margin as the latter slipped into the incision. Thus there was a definite end point which could be measured repeatedly and accurately. When the conditions were such that complete prolapse did not occur, special notation is made describing what did occur. Several readings were usually taken at each test.

Each time that the iris prolapsed, the pressure within the system was released and the iris replaced by means of a loop or spatula.

RESULTS

Group 1.—The results in 13 eyes prepared as described are given in table 1.

Eye 1 illustrates well the results in a typical successful, uncomplicated experiment. With a simple linear incision unprotected against prolapse of the iris by any type of reenforcement (column a), prolapse occurred at a pressure of about 30 mm. of mercury. When the incision was covered by a conjunctival flap (column b), the pressure had to be increased about a third in order to effect prolapse. After the lips of the wound had been closed by one corneal (or rather sclerocorneal suture (column c), the pressure had to be raised eightfold in order to force out the iris, and when an iridotomy opening had been added, no prolapse occurred at the greatest pressure which could be recorded on the manometer used. The saline solution used in the system squirted vigorously through the opening.

Each eye varied somewhat from all of the others. In some the conjunctival flap offered no resistance to prolapse that could be measured, and in only 1 eye (8) was the resistance at all considerable. One sclerocorneal suture, on the other hand, was very effective. The pressure required to force prolapse was raised from twofold to eightfold (eyes 1, 2, 4, 6, 7, 8, 9, 11, 12 and 13) regularly, and only once did it fail to offer great resistance to prolapse (eye 10).

Unless the iris made close contact with the posterior corneal surface, prolapse did not occur with reasonable pressure, as illustrated by eye 2 (column a). In this instance the iris herniated readily at 20 mm. when in contact, but sometimes the pressure had to be doubled and considerable fluid had to be passed through the eye before it would make contact. Once the iris touched the cornea, herniation was prompt. This point was noted during the clinical work in India.[1]

An iridotomy opening added to the sclerocorneal suture made it almost impossible to produce prolapse when the opening acted well. However, the iris of a cow is so constructed that, after being prepared as these eyes were, an iridotomy opening could not be depended on to leak. In fact, the iris of some eyes seemed to be well nigh leakproof. If the hole would not emit fluid, prolapse occurred just as easily as if iridotomy had not been done; in fact, it occurred even more easily, because the structure of the iris had been weakened. After the lens and vitreous have been removed from an eye of an ox, there is found a complete ring of extremely soft tissue in the form of a flap on the posterior surface of the iris near the root. It is a portion of the attachment of the lens and is the structure that so often blocks the iridotomy opening. Sometimes the iris itself is so thick and so constructed that blockage of this nature is likely to occur. Eye 13 illustrates the action of an iridotomy opening that functions well for a time, and then blockage occurs. In some of the other eyes blockage and prolapse occurred at much lower pressure (eye 4). In some instances leakage through the iridotomy opening was so rapid that it was difficult to get the pressure up with most vigorous pumping (eye 7) and extremely difficult to force a prolapse, even with large volumes of fluid flowing through the eye.

Group 2.—In several respects the preparation of the eyes in group 1 was not entirely satisfactory. This was especially true of the conjunctival flap and the cotton used in the vitreous space. For that reason the preparation was modified in group 2, as described, in order to see if results would be more uniform or would be altered in some other way. Five eyes were used for this group.

Tests were made, readings were recorded and the iris was replaced as in group 1. After the tests with conjunctival flap had been completed, the conjunctiva was divided at its corneal attachment and removed.

TABLE 1.—*Results Obtained in Thirteen Ox Eyes Subjected to Fluid Pressure Within the Eye After Various Surgical Procedures**

Ox Eye No.	Length of Incision, Mm.	Pressures (Mm. of Mercury) at Which Complete Prolapse Occurred and Results: (a) With Simple Incision, Pressure	(b) With Conjunctival Flaps: Pressure	(b) With Conjunctival Flaps: No. of Sutures	(c) With Sclerocorneal Sutures: Pressure	(c) With Sclerocorneal Sutures: No. of Sutures	(d) With Sclerocorneal Sutures Plus One Iridotomy Opening: Pressure	(d) With Sclerocorneal Sutures Plus One Iridotomy Opening: No. of Sutures	Comment
1	..	30	48	1	250	1	300+; no prolapse	1	(d) Water squirted vigorously through iridotomy opening; no prolapse occurred at highest pressure manometer was able to record
		32	50	1	246	1			
		30	42	1	250	1			
2	17	20 to 40	23	1	185	1	300+; no prolapse	1	(a) Prolapse occurred at 20 mm. if iris was in contact with cornea when pressure was started; pressure rose as high as 40 mm. if iris was not in contact, as eye leaked before contact between iris and cornea was followed by prolapse; (d) water squirted vigorously through iridotomy opening
					170	1			
					240	1			
3	20	18	24	1	26	1	300+; no prolapse	2	
		16	28	1	26	1			
		19	21	1	22	1			
			24	1					
			38	2					
			33	2					
			33	2					
4	20	33	29	1	156	1	134; prolapse	2	(d) Iridotomy opening tended to block up; water squirted for a time, but no prolapse occurred; opening would block suddenly, prolapse following; at 1 test water squirted well up to 104 mm., when it suddenly stopped; prolapse occurred at 110 mm.
		30	28	1	74	1	122; prolapse	2	
		31	29	1	74	1	135; prolapse	2	
					66	1			
					93	2			
					73	2			
					80	2			
5	16	28	38	1	300+	1	.....	..	(c) Pressure was carried to limits of manometer, causing incarceration but not complete prolapse; interference was possibly due to a mass of lens matter found within eye when it was dismounted
		30	37	1	300+	1			
		32	40	1	300+	1			
6	19	22	49	1	228	1	{60; leakage began	..	
		22	24	1	142	1	{150; prolapse		
		24	36	1	138	1			
			26	1					
			30	1					
7	19	28	32	1	262	1	{17; leakage began	1	(c) At first two pressures (262 and 300) leakage occurred at one angle of the incision but no prolapse, although iris was incarcerated; prolapse was complete with the other 3 pressures; (d) leakage through iridotomy opening was so rapid that pressure could not be raised above 175 mm. at first trial; iris moved only until iridotomy opening came into incision; no prolapse occurred; at second trial vigorous pumping was necessary to raise pressure to 162 mm., at which prolapse occurred
		24	27	1	300	1	{175; no prolapse	1	
		30	25	1	200	1	162; prolapse	1	
		25			110	1			
					143	1			

8	20	38	64	1	236	1	{50; leakage	1	
		20	48	1	230	1	{140; prolapse		
		30	74	1	160	1	{25; leakage	1	
		22	80	1			{110; prolapse		
9	25	38	38	1	70	1	{20; leakage	..	(d) Iris folded on itself at iridotomy opening, partially sealing opening; prolapse followed
		36	36	1	74	1	{68; prolapse		
		38	30	1	70	1	64; prolapse		
					66	1	40; prolapse		
10	25	20	34	1	30	1	24; prolapse	1	(d) Iridotomy did not seem to retard prolapse
		20	36	1	20	1	30; prolapse	1	
		24	40	1	28	1	30; prolapse	1	
		30	20	2	28	1			
		30	20	2	130	2			
		26	30	2	70	2			
					120	2			
					48	2			
11	17	18	20	1	80	1	100; prolapse	1	
		18	18		56		130; prolapse		
		20	18		49		106; prolapse		
			20		100				
					40				
					36				
					44				
12	15.5	32	36	1	200	1	116; leakage	1	(d) At first 4 tests iris entered wound at the indicated pressures, fluid escaped, and prolapse went no further
		24	34		140		Incomplete prolapse		
		30	32		140		120; leakage		
		30	28				Incomplete prolapse		
							90; leakage		
							Incomplete prolapse		
							80; leakage		
							Incomplete prolapse		
							116; complete prolapse		
13	17	60	60	1	210	1	{40; leakage	1	(d) At first test prolapse occurred to right of suture and in other 2 to left
		56	46		184		{100; water squirted vigorously		
		38	44		340		{160; iridotomy opening blocked		
		36	46		190		{240; prolapse		
		50					{76; squirting		
							{170; iridotomy opening blocked		
							{260; prolapse		
							{60; squirting		
							{136; prolapse		

* The four surgical procedures represented in the four lettered columns were: (a), simple corneal incision at the limbus; (b), the same incision covered by a conjunctival flap drawn over the incision and stitched to the cornea; (c), the same incision closed by one simple corneal or sclerocorneal suture placed through both lips of the incision, and (d), the same as (c) with the addition of one peripheral iridotomy opening. "Leakage" in column d indicates that the iridotomy functioned and that fluid spurted through the opening.

TABLE 2.—*Results Obtained in Five Ox Eyes Subjected to Fluid Pressure Within the Eye After Various Surgical Procedures* *

Ox Eye No.	Length of Incision, Mm.	Pressures (Mm. of Mercury) at Which Prolapse Occurred and Results						
		(a) With Simple Incision, Pressure	(b) With Conjunctival Flaps		(c) With Sclerocorneal Sutures		(d) With Sclerocorneal Suture and Iridotomy Opening	
			Pressure	No. of Sutures	Pressure	No. of Sutures	Pressure	No. of Iridotomy Openings
14	15	54 28 34 38	66 46 62	3	80 74 74	1	80; incarceration in the incision; no prolapse 88; incarceration in the incision; no prolapse 60; leakage; no prolapse 42; incarceration in the incision; leakage; no further prolapse 84; incarceration and leakage	1
15	15	52 42 42 28 36	48 36 36 34	3	192 194 134 126	1	90; prolapse 94; incarceration 134; incarceration 132; incarceration	1 2
16	16	48 26 36 32	58 54 50	2	234; incomplete prolapse 116; incomplete prolapse 120; incarceration began 260; incomplete prolapse 106; incarceration began 260; incomplete prolapse	1	114; incarceration 276; incomplete prolapse 100; incarceration 268; incomplete prolapse 280; incomplete prolapse 100; leakage 280; no prolapse 78; leakage 290; no prolapse 80; leakage 274; no prolapse 50; leakage 290; no prolapse	1
17	15	46 70 52 54 50 42	(b1) 60 48 50 58 58	(b2) 46 46 38	290; incarceration 238; incarceration 294; incarceration 250; incarceration; leakage 264; leakage; incomplete		220; no leakage; no prolapse 260; no leakage; no prolapse 144; leakage 240; no prolapse 112; leakage 232; no prolapse 94; leakage 268; no prolapse 246; incarceration; slow leakage 220; no leakage; no prolapse	
18	16	38 44 44 44	(b1) (b2) (b3) 56 70 180; incarceration 50 70 250; incomplete prolapse 45 64 46 260; prolapse complete		296 380 204 180		100; leakage 460; incarceration of ragged iris	

(b) Conjunctival flap was put on tension and sutured to sclera 9 mm. from limbus; lay smoothly over entire length of incision
(d) Complete prolapse did not occur; at indicated pressures iris moved until iridotomy opening came into incision; leakage occurred but no further movement of iris

(b) Conjunctival flap was stitched to sclera

(b) Conjunctival flap was stitched to sclera by 2 sutures 10 mm. posterior to incision
(d) At first 3 trials iris was incarcerated without leakage through iridotomy opening; incomplete prolapse occurred; at last 4 trials, leakage was good and prolapse did not occur

(b1) Conjunctiva was stitched to sclera by 3 sutures 7 to 15 mm. posterior to incision
(b2) Conjunctiva was stitched firmly to tendon stumps 5 mm. posterior to limbus, under tension
(d) Results not entirely satisfactory; incision was apparently blocked either by wax mold or by detached retina, which was found to be in shreds after experiment

(b1) Conjunctiva was pulled back to posterior pole and closed by purse-string suture, thus enclosing entire globe
(b2) Conjunctiva was stitched tightly to sclera by 3 mattress sutures 4 mm. posterior to incision
(b3) Conjunctiva was stitched tightly by 3 mattress sutures to sclera 1.5 to 2 mm. posterior to incision; conjunctiva was under tension; as prolapse occurred iris impinged directly on the sutures, scarcely having room to prolapse

* In these eyes the conjunctiva was retained intact, but was dissected away from the sclera in that sector in which the limbic incision was made. In each eye

The results in these 5 eyes are shown in table 2.

In general, the results were similar to those obtained with the first group. The most effective means of preventing prolapse of the iris was found to be the sclerocorneal suture combined with an iridotomy opening, provided the opening emitted fluid freely. Eye 16 illustrates this well. Incarceration or incomplete prolapse occurred after the incision had been closed by a sclerocorneal suture, both with and without an iridotomy opening, although extremely high pressures (around 250 mm. of mercury) were required. After several trials in which the iridotomy opening did not leak, it suddenly began to function well and thereafter there was no prolapse, even up to a pressure of 290 mm., the highest which could be forced.

In eye 14 the iridotomy opening was not accurately placed to coincide with the incision. Consequently the iris slid on the posterior corneal surface and into the wound until the iridotomy opening entered. Then the progress of the iris stopped, the fluid spurted vigorously through the small opening, and no further prolapse occurred.

The action of conjunctival flaps was studied especially carefully in this group. As already described, the conjunctiva was left intact and the incision lay completely subconjunctival. Several methods of stitching it were tried as follows: (1) drawing the conjunctiva over the entire globe and closing it with a purse-string suture at the posterior pole (eye 18), (2) stitching it to the sclera with several mattress sutures at a distance posterior to the incision varying from 1.5 to 15 mm. (eyes 14, 15, 16, 17 and 18) and (3) stitching it to the tendon stump of the ocular muscle [2] 5 mm. posterior to the incision (eye 17, b_2). In all cases the conjunctiva lay smoothly over the entire length of the incision, and in most it was under considerable tension.[3] The only instance in which it offered effective resistance to prolapse was in eye 18 (column b_3), in which the conjunctiva had been stitched under tension to the sclera by three mattress sutures 1.5 to 2 mm. posterior to the incision. Even in this case incarceration occurred easily at fairly low pressure, but the space under the tense conjunctiva, between its attachment and the sutures, was so limited that there was not room for the iris to prolapse. It moved through the incision and up against the sutures until the confined space was filled, and then progress stopped.

One sclerocorneal suture alone in this group also was extremely effective in resisting prolapse. Four of the 5 eyes withstood pressures from 190 to 380 mm. before prolapse occurred. In 1 eye (no. 14) it was not so effective, the pressure at which prolapse occurred being only double that at which it occurred with the simple incision.

2. The eye of an ox has almost a continuous circle of muscle attached 5 to 10 mm. posterior to the limbus.

3. The conjunctiva of the eye of an ox, unlike that of man, is fairly strong and inelastic. It can be placed under considerable tension.

TABLE 3.—*Results Obtained in Eight Ox Eyes Subjected to Pressure Against the Lower Portion of the Cornea After Various Surgical Procedures* *

Ox Eye No.	Length of Incision, Mm.	Pressures at Which Prolapse Occurred, Mm. of Mercury: (a) With Simple Incision	(b) With Conjunctival Flap	No. of Sutures	Highest Pressures Obtained (in Mm. of Mercury) and Results: (c) With Sclerocorneal Suture: Pressure	No. of Sutures	(d) With Sclerocorneal Suture Iridotomy Opening: Pressure	No. of Iridotomy Openings	Comment
19	15.5	44 46 44 30 28 28	46 38 32 36	1	100; incarceration; leakage 102; leakage; no prolapse 144; prolapse 104; prolapse	1	94; leakage; incarceration 90; prolapse 86; prolapse {20; leakage began {76; no prolapse 56; iridotomy opening blocked; incarceration 72; no prolapse	1	(a) Corneal incision made as in group 1 (b) Conjunctival flap was drawn forward across incision and stitched to cornea
20	15	28 28 34	50 60 60 60	1	100; leakage; no prolapse 100; leakage; no prolapse 188; leakage; no prolapse 210; leakage; no prolapse	1	.....	..	(c) Fluid squirted from incision through leak which acted like an iridotomy opening; prolapse could not be forced or leak stopped; after trials with conjunctival flap conjunctival stitch was removed and pressure made again as in test with simple incision, prolapse occurring at 28 and 34 mm.; after trials with corneoscleral sutures stitch was removed and further trials made as with simple incision, prolapse occurring at 38 mm.

21	15	50	72	1	160; no prolapse	1	204; no prolapse; no leakage	1		
		44	48	1	200; no prolapse; small incarceration		172; incarceration; iris everted	2		
		44	42		196; no prolapse; small incarceration		198; incarceration			
		46			184; no prolapse; small incarceration					
					220; prolapse					
22	15	84	..	..	.....	..	.....	..	Accidental iridotomy was done while making the incision; prolapse could not be forced; incision was blocked by wax mold; failure	
23	15	48	54	2	120; prolapse	1	84; leakage; no prolapse	1	(c) Detached retina came into pupil; result was probably inaccurate	
		34	48		196; incarceration		134; leakage; incarceration			
		34	46		124; small incarceration; no prolapse		108; incarceration		(d) Iris seemed to protrude more readily than before iridotomy	
		28	36		132; prolapse					
					196; prolapse; see (c) under comment					
24	15.5	54	44	3	114; no prolapse	1	130; prolapse to left	1		
		36	40		140; prolapse to left		130; prolapse to right			
		32	36		130; prolapse to left		140; incarceration			
		32					90; leakage; iris everted; iridotomy opening blocked			
25	15	36	64	2	90; no prolapse	1	100; small incarceration	1	(b) Flap was rather tense—was stitched to sclera 10 mm. posterior to incision	
		30	46		122; incarceration		100; flood leakage; no prolapse			
		28	38		88; incarceration		104; incarceration; no leakage			
			52		100; leakage to right of suture and incarceration to left		74; good leakage; small incarceration			
							84; incarceration; no leakage			
					120; leakage to right of suture and incarceration to left		74; good leakage; no prolapse; no incarceration			
26	15	68	70	2	152; no prolapse	1	110; leakage; no prolapse	..	(d) At each of first 4 trials, iris moved into incision as far as iridotomy opening; leakage began and progress of the iris ceased; at the last 2 trials, eye was connected to water flask as in *B* of illustration; prolapse could not be forced up to 560 mm., at which point mercury burst from the manometer; water squirted through iridotomy opening in long fine stream	
		60	62		190; no prolapse		100; leakage; no prolapse			
		54	52		140; no prolapse		126; leakage; no prolapse			
		60	66		140; no prolapse		142; leakage; no prolapse			
							550; moderate leakage; no prolapse			
							560; moderate leakage; no prolapse			

* The eyes were mounted as in *C* of the illustration and connected directly with a manometer. The conjunctiva was retained intact, and the limbic incision was made subconjunctivally, as in group 2. The four surgical procedures used were the same as for group 1. After each test the eye was refilled by a hypodermic needle.

In all the experiments thus far a large volume of fluid had been used for making intraocular pressure. For practical purposes the volume was unlimited.

In clinical work, of course, there is no question of large volumes of fluid flowing through the eye. When the small amount of aqueous contained in the posterior chamber has escaped, danger of prolapse is over for the time being.[1] All that is necessary to do in order to avoid prolapse of the iris in case the wound should gape is to provide some safe means of escape for that small quantity. If the fluid had been limited in these eyes to what could be contained within the anterior and posterior chambers, there would have been no prolapse in many of them, for instance in eyes 6, 7 and 8.

Group 3.—Some further experiments were done in which the eyes were connected directly with the manometer and the volume of fluid limited to what each eye could contain, thus simulating to a degree the condition found at clinical operations. There were 8 eyes in this group (table 3). They were prepared as previously described, with the exception of eye 19 in which the incision and conjunctival flap were made as in group 1. The conjunctiva was variously handled. In eyes 20 to 24 inclusive the conjunctiva was drawn smoothly back over the incision and stitched to Tenon's capsule, or the tendon of ocular muscles. In eyes 25 and 26 it was stitched down to the sclera.

The tests were made as follows: Each eye was mounted on the clamp as before, a hypodermic needle was forced through the sclera just at the edge of the clamp, and the eye was filled with physiologic solution of sodium chloride. The syringe was supported in the right hand with the thumb immobilizing the plunger; pressure was made on the lower portion of the cornea with the left thumb as the fingers rested on the clamp. The pressure in the manometer was read by an assistant when prolapse occurred. A sort of milking movement was used with the thumb against the cornea in order to force prolapse whenever possible. After each prolapse the iris was reduced by means of a vectis as before, and the eye was refilled with the syringe. At each trial pressure was maintained and increased until the chambers were collapsed and progress of the iris had ceased. The results are recorded in table 3. In general, they were similar to those found in the first two groups of eyes except that prolapse failed to occur more frequently on account of the limited amount of fluid. If prolapse failed to occur before the fluid in the posterior chamber had escaped, it could not be induced thereafter (eyes 19, 21, 25 and 26).

This group again illustrates the fact that iridotomy is useless, or worse, if the opening becomes blocked. However, it is a great protection against prolapse of the iris if the hole stays open and emits fluid freely. For instance, in eye 26 the iridotomy opening operated well,

although it was tiny. It seemed impossible to force a prolapse. Finally, in order to see how much pressure the eye could stand, it was connected to the flask, as in groups 1 and 2 (*B* of the illustration), and fluid was forced into it by pumping with the hand bulb. At the first test the pressure was raised to 560 mm. without prolapse or incarceration. The cornea became white under the pressure, and fluid spurted from the iridotomy opening like a tiny fountain. At a second test the capacity of the manometer was exceeded at a plus 560 mm. and mercury sprayed all over the table and floor, but there was neither incarceration nor prolapse.

The results in each group are averaged in order to get a better bird's-eye view.

Forty-six tests were made on the eyes in group 1 (table 4) in which the simple unprotected incision was made. Prolapse of iris occurred in

TABLE 4.—*Summary of Results in Group 1 with Averages of Pressures Obtained* *

	(a) Open Limbic Incision			(b) Incision Covered by Conjunctival Flap			(c) Incision Closed by Sclerocorneal Suture			(d) Incision Closed by Sclerocorneal Suture; Iridotomy Opening Added		
Total number of tests.....	46			50			54			24		
Average pressure attained in total number of tests.....	28			35			132			137		
Result	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse
Number of occurrences.....	46	0	0	50	0	0	54	0	0	16	4	4
Average pressure.....	28	..	..	35	..	..	132	..	..	115	101	269

* The incision was made just anterior to the attachment of the conjunctiva. The conjunctival flap was prepared by dividing the conjunctiva at its attachment and drawing it across the incision and stitching it to the cornea. Pressure was made by forcing fluid (saline solution) into the eye. The volume of pressure fluid was unlimited. Pressures are expressed in millimeters of mercury.

all at an average pressure of 28 mm. Fifty tests were made with the conjunctival flap, also with 100 per cent prolapse. The pressures required averaged 35 mm., or an increase of less than one fourth. Fifty-four tests were made with the sclerocorneal suture, and again prolapse occurred in all, but the pressure had to be raised until more than four times as great as in eyes with an unprotected incision (132 mm.). After an iridotomy opening was added to the sclerocorneal suture, 24 tests were made at an average pressure of 137 mm. Prolapse occurred in 16 (or two thirds) at an average pressure of 115 mm. Incarceration resulted in 4 at a pressure of 101 mm., and in 4 neither prolapse nor incarceration occurred at 269 mm. The last 4 tests, as a matter of fact, represent quite a number of measurements in each case. When a manometer was used that recorded only 300 mm., all pressure readings in a given eye which ran that high without the occurrence of prolapse were simply grouped under one test at 300 +.

Twenty-three tests were made on the eyes in group 2 (table 5) in which the unprotected incision was used. Prolapse occurred in all tests at an average pressure of 43 mm. Of 28 tests with the conjunctival flap, prolapse occurred in 25 at an average of 52 mm. Prolapse was incomplete in 3 although the average pressure was raised to 230 mm.

TABLE 5.—*Summary of Results in Group 2 with Averages of Pressures Obtained* *

	(a) Open Limbic Incision			(b) Incision Covered by Conjunctival Flap			(c) Incision Closed by Sclerocorneal Suture			(d) Incision Closed by Sclerocorneal Suture; Iridotomy Opening Added		
Total number of tests	23			28			20			25		
Average pressure attained in total number of tests	43			71			207			201		
Result	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse
Number of occurrences	23	0	0	25	3	0	11	9	0	2	9	14
Average pressure	43	..	..	52	230	..	176	245	..	108	219	203

* The incision was made at the limbus just posterior to the conjunctival attachment. The conjunctival flap was first prepared by separating the intact conjunctiva off the sclera as far as its corneal attachment. When the conjunctiva was laid back in position on the sclera, the incision lay completely subconjunctival. Pressure was made by forcing fluid into the eye. The volume of pressure fluid was unlimited. The pressures are expressed in millimeters of mercury.

TABLE 3.—*Summary of Results in Group 3 with Averages of Pressures Obtained* *

	(a) Open Limbic Incision			(b) Incision Covered by Conjunctival Flap			(c) Incision Closed by Sclerocorneal Suture			(d) Incision Closed by Sclerocorneal Suture; Iridotomy Opening Added		
Total number of tests	28			26			29			26		
Average pressure attained in total number of tests	40			50			141			111		
Result	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse
Number of occurrences	28	0	0	26	0	0	6	10	13	4	12	10
Average pressure	40	..	..	50	..	..	145	143	139	109	113	109

* The preparation of the eyes was the same as in group 2, but pressure was made externally with the thumb against the cornea. The volume of pressure fluid was limited to that within the eye. The pressures are expressed in millimeters of mercury.

Twenty tests were made with the sclerocorneal suture with pressures averaging 207 mm. In 11 there was complete prolapse at 176 mm. and in the other 9, incarceration at 245 mm. After an iridotomy opening was added to the sclerocorneal suture, 25 tests were made with pressures averaging 201 mm. In 2, prolapse occurred at 108 mm. Incarceration occurred in 9 at 219 mm. There was no prolapse in 14 with an average pressure of 203 mm.

Table 6 contains the averages for group 3. The results on eye 22 were omitted because of accidental mutilation of the iris.

Twenty-eight tests were made on the other 7 eyes in which the simple unprotected incision was made. Prolapse occurred 28 times (100 per cent) at an average pressure of 40 mm. Twenty-six tests were made on eyes with conjunctival flaps which covered the incision completely. Again prolapse occurred every time. The average pressure was 50 mm., an increase of one-fourth over that recorded when the unprotected incision was used. Twenty-nine tests were made on eyes with one sclerocorneal suture. The average pressure reached was 141.5 mm., three and a half times as great as that recorded when the unprotected incision was used. Prolapse occurred in 6 tests at an average pressure of 145 mm. There was no prolapse in 13 tests at an average pressure of 139 mm. and incarceration of the iris occurred in 10 at an average pressure of 143 mm.

When an iridotomy opening was added (column d) the results were about the same as when the sclerocorneal suture alone was used. The

TABLE 7.—*Summary of Results of All Tests on Twenty-Six Eyes with Averages of Pressure Obtained* *

	(a) Open Limbic Incision			(b) Incision Covered by Conjunctival Flap			(c) Incision Closed by Sclerocorneal Suture			(d) Incision Closed by Sclerocorneal Suture; Iridotomy Opening Added		
Total number of tests.....	100			107			108			75		
Average pressure attained in total number of tests.....	34.4			41.8			149			149.8		
Result	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse	Prolapse	Incarceration	No Prolapse
Number of occurrences.....	100	0	0	104	3	0	71	19	13	22	25	28
Average pressure.....	34.4	..	..	41.8	..	..	140.1	191	139	116	149	179

* Pressures are expressed in millimeters of mercury.

pressures did not always go so high, because more or less successful leakage occurred through the opening, making it difficult to reach a high pressure. In 26 tests the average pressure reached was 111 mm. There were 4 prolapses at 109 mm. and 12 incarcerations at 113 mm., and in 10 tests there was neither prolapse nor incarceration with the pressures averaging 109 mm.

A summary of the results of all the tests on the three groups of eyes into a single set of figures is given in table 7.

SUMMARY

Twenty-six ox eyes were prepared and mounted on a clamp in such a way that a measured amount of pressure could be applied to them, either externally or internally. These eyes were tested, after being subjected to four different operative procedures, as to their abilities to withstand pressure. Each eye was tested under all four operative con-

ditions. It was found that even with short limbic incisions the wound would gape readily, and prolapse of the iris would occur at comparatively low pressures.

When the incision was covered with conjunctiva prepared in half a dozen different ways comparable to methods used in clinical operations, a slightly increased pressure was necessary to effect prolapse. The increased ability of the incision to withstand pressure after being reenforced with conjunctival flaps was so slight, however, that such flaps may be considered as practically worthless in this respect. There was one exception to the rule. When the conjunctiva was drawn across the incision tightly and stitched under tension to the sclera within 2 mm. of the incision, the wound withstood considerable pressure without complete prolapse. Incarceration, however, occurred easily even in this instance.

A sclerocorneal suture placed accurately in the lips of the incision at about the midpoint reenforced the wound effectively, increasing the pressure necessary to effect prolapse from twofold to tenfold.

An iridotomy opening made in that portion of the iris underlying the incision definitely furnished further protection against prolapse when it emitted fluid freely. However, the eye of an ox is so constructed that in some instances the iris is well nigh leakproof. In such cases iridotomy was worse than useless.

The mechanics of prolapse of the iris in these eyes was found to be the same as that which was found in clinical work in India.[1] The essential requirements for prolapse were found to be: (*a*) gaping of wound with escape of fluid from the anterior chamber, (*b*) application of the iris to the posterior surface of the cornea in such a way as to cover the breach in the incision thus forming, (*c*) a relatively watertight seal which cut off the escape of fluid posterior to the iris and (*d*) continuing pressure which forced out the latter fluid, thus forming a balloon of the iris between the lips of the incision.

Prolapse of the iris is possible whenever there is enough intact iris present to cover from behind a breach in the cornea. Iridectomy openings in some other portion of the iris, even though close by, will not prevent the prolapse.

CONCLUSIONS

1. Conjunctival flaps and pockets are essentially ineffective in reenforcing limbic incisions so as to prevent gaping of the wound and herniation of the iris when healing effects are eliminated.

2. Sutures placed directly in the lips of the incision are effective in holding the wound closed and preventing herniation of the iris.

3. An opening in the iris which allows the fluid to escape from the posterior chamber is a further protection against herniation of the iris.

TRANSPLANTATION (IMPLANTATION) OF THE LACRIMAL SAC IN CHRONIC DACRYOCYSTITIS

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OMAHA

The various methods of treating chronic dacryocystitis by the creation of an artificial passage into the nose have been reviewed extensively within recent years. Noteworthy in this respect are the publications of Chandler [1] and of Kaleff,[2] in which the advantages and disadvantages of the modifications of the Toti operation (dacryocystorhinostomy) are fully discussed. These operative procedures can properly be classified into four groups, all being external in type:

Group 1 consists of procedures in which the anterior and posterior flaps of nasal mucous membrane and lacrimal sac respectively are sutured together, such as the method of Ohm [3] or of Depuy-Dutemps and Bourguet.[4]

Group 2 consists of procedures in which one or more flaps of nasal mucous membrane are sutured to the anterior or posterior wall of the sac, but without forming an exact or complete anastomosis (Basterra [5] and Kuhnt [6]).

Group 3 consists of procedures in which the lacrimal sac is removed, and a small piece is left immediately surrounding the opening of the canaliculi to empty into a large opening into the nose. Sutures are

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1. Chandler, P. A.: Dacryocystorhinostomy, Tr. Am. Ophth. Soc. **34**:240, 1936.

2. Kaleff, R.: Eine vereinfachte Modifikation der Dacryocystorhinostomia externa, Ztschr. f. Augenh. **91**:140, 1937.

3. Ohm, J.: Geschichtliche Bemerkung zur Verbesserung der Totischen Operation, Klin. Monatsbl. f. Augenh. **64**:848, 1920; **77**:825, 1926.

4. Depuy-Dutemps and Bourguet: Procédé plastique de dacryocysto-rhinostomie et ses résultats, Ann. d'ocul. **158**:241, 1921.

5. Basterra, J.: Eine vereinfachte Modifikation der Dacryocystorhinostomie externa, Arch. de oftal. hispano-am. **25**:233 and 293, 1925; **27**:110, 1927; cited by Kaleff.[2]

6. Kuhnt, H.: Notiz zur Technik der Dakryocystorhinostomie von Toti, Ztschr. f. Augenh. **31**:379, 1914.

not used to unite the mucous membrane of the nose with the portion of the sac (Blascovicz,[7] Hötte [8] and others).

Group 4 consists of procedures in which the lower end of the sac is transplanted or implanted into and through a new opening made into the nose.

REVIEW OF THE LITERATURE ON TRANSPLANTING OR IMPLANTING THE LOWER END OF THE TEAR SAC INTO THE NOSE

In 1904 Speciale-Cirincione,[9] working in the clinic of Professor Cirincione in Italy, performed the following operation on a cadaver: By means of a skin incision the tear sac was exposed and was freed from the surrounding tissue at its lower portion. After the sac was cut transversely as far down in the bony canal as possible, the tear sac was elevated and an opening measuring 9 mm. was drilled through the nasal process of the superior maxilla. The mucous membrane of the nose covering the artificial opening was incised, and the lower free portion of the tear sac was inserted through the bony opening. Subsequently the operation was attempted on 2 patients, both having a chronic obstructive dacryocystitis. For the first patient sutures were not used to hold the sac in place, but for the second the circumference of the sac was sutured to the incised mucous membrane within the nose. The results of this operative procedure, however, were not satisfactory, necessitating extirpation of the tear sac in both instances. In the same year (1904) Toti [10] published his article on dacryocystorhinostomy, and Toti's operation was adopted in Professor Cirincione's clinic.

In 1911 Forsmark,[11] in Sweden, described a somewhat similar operation. The tear sac was freed from its surrounding tissue, and the lower part was isolated and cut as low down as possible. After this, a comparatively large defect was made with a chisel through the lacrimal bone into the middle meatus of the nose. The proximal end of the tear sac, anchored with a thread, was pulled into the nasal cavity. The thread was brought out through the nostril and fastened to the cheek. This operation was performed on 29 patients. Of these, all observed over a period of a year or more, only 50 per cent had a good result in terms of symptoms.

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7. Blascovicz: Dacryocystorhinostomy, Szemészet **2**:190, 1912; cited by Chandler.[1]

8. Hötte, F. A.: Ueber Dakryozystorhinostomie mit Modificationen und Total Extirpation mit Rhinostomie, Klin. Monatsbl. f. Augenh. **60**:358, 1918.

9. Speciale-Cirincione, F.: Sulla dacriorinostomia (secondo Toti), Clin. ocul. **14**:1369, 1913.

10. Toti, M. A.: Nuovo metodo conservatore di cura radicale delle suppurazioni cronische del sacco lacrimale (dacriocistorhinostomia), Clin. mod. **10**:385, 1904.

11. Forsmark, E.: On Dacryocystorhinostomy, Hygiea **73**:1432, 1911.

Neumayer [12] reported an operation from Germany in 1911, the technic of which seems to be identical to that employed by Forsmark. Neumayer did not give a full account of his methods but stated that his results were "satisfactory."

In 1920 Burch,[13] of St. Paul, described a method in which he freed the lacrimal duct from its bony canal downward for a distance of 5 or 6 mm. The lacrimal crest was removed with a burr or biting forceps, and a bony window was made also with a burr or a 5 mm. dental trephine through the nasal process of the superior maxilla. The lacrimal duct, previously lifted from its canal, was slit on its nasal side from its lower end upward a short distance into the sac; the duct and sac were tucked through the opening in the bone. A soft rubber catheter or a lead stylet introduced through the canaliculus aided in holding the duct and sac in place until healing took place. The operation as described was done only three times, and the opening remained patent twice.

MacMillan,[14] of Montreal, Canada, reported on a new operation for the treatment of lacrimal obstruction in 1921; he made the opening into the nose through the lacrimal bone, so that the bony defect appeared beneath the middle turbinate on the nasal side. The lacrimal sac was then drawn down through this opening by means of sutures attached to the lower end of the sac. By tying the two ends of the suture over a piece of gauze inserted into the nostril, the sac was held in place in its new location. In 1932 MacMillan [15] reported the results of 25 operations so performed. Seventeen of the patients were completely cured (no tearing and no discharge), 4 were improved (with little or no discharge but with tearing and no patency with the syringe except after probing), 3 did not obtain any improvement and 1 did not reply to inquiry.

Reports of operations in which the lower end of the lacrimal sac was transplanted into a window made into the nasal cavity were also given by Fazakas,[16] in Hungary, in 1924; by de Lieto Vollaro,[17] of

12. Neumayer, in discussion on von Eicken: Ein neues Verfahren zur Beseitigung von Stenosen des Tränennasenkanals, Verhandl. d. Ver. deutsch. Laryng., 1911, p. 600.

13. Burch, F. E.: Conservation of the Lacrimal Sac: A Method, Tr. Am. Acad. Ophth., 1920, pp. 137-145.

14. MacMillan, J. A.: A New Operation for the Treatment of Lacrimal Obstruction, Am. J. Ophth. **4**:448, 1921.

15. MacMillan, J. A.: Transplantation of the Lacrimal Sac in Chronic Suppurative Dacryocystitis, Arch. Ophth. **8**:831 (Dec.) 1932.

16. Fazakas, A.: Neue Modifikation der Dakryozystorhinostomie, Klin. Monatsbl. f. Augenh. **73**:426, 1924.

17. de Lieto Vollaro, A.: Di un procedimento personale di dacriocistorinostomia semplificata, a modificazione del metodo fondamentale del Toti, Boll. d'ocul. **8**:561, 1929.

Milan, Italy, in 1929; by Del Barrio,[18] of Seville, Spain, in 1929; by Rosengren,[19] of Lund, Sweden, in 1931, and by Stock,[20] of the University of Tübingen, Germany, in 1934.

It is of interest to note that the operation was successful in the 4 cases reported by Fazakas. He advised making the bony opening through the ascending process of the maxilla when possible. Del Barrio, employing the technic advocated by Fazakas, reported 4 operations, 2 of which were successful at the end of ten and fourteen months' observation. De Lieto Vollaro transplanted the tear sac through an opening made at the floor of the lacrimal fossa, perforating the lacrimal bone. At first he used sutures to unite the wall of the sac and the periosteum surrounding the nasal opening, but later he suspended the sac in the nasal opening. Apparently his results were satisfactory for a few persons observed over a period of ten years. Rosengren reported his experience with the technic advocated by Burch, successful results being obtained in all 10 cases in which it was used. Stock cited the results obtained in 45 cases; 40 of the patients were followed over a period of four years, and 6 failures were observed. Instead of perforating the lacrimal bone with a chisel, Stock used a 10 mm. trephine.

COMMENT

The results of this operation as performed by the various authors are difficult to evaluate. The successful maintenance of a patent passage from the lacrimal sac to the nasal cavity has been reported as varying from 50 to 100 per cent in cases in which transplantation was performed. The percentage of successes has been higher in cases in which the lower end of the sac was implanted into an opening made through the ascending process of the maxilla than in those in which the perforation was made through the floor of the lacrimal fossa. The anatomic relation of the parts therefore seem to be an important consideration.

The lacrimal fossa is about 14 mm. in height and 6 to 7 mm. across. It is divided vertically by a line corresponding to the junction of the maxilla with the anterior edge of the lacrimal bone, and each of the two bones contribute approximately an equal part in its formation. How-

18. Del Barrio, A.: Dacriocistorinostomia y sus diversas tecnicas, Arch. de oftal. hispano-am. **29**:18, 1929.

19. Rosengren, B.: A Modification of Toti's Operation, Forhandl. oftal. Selsk., Copenhagen, 1931, p. 24; in Hospitalstid., May 19, 1932.

20. Stock, W.: Ueber die Erfolge der Operation der Tränensackeiterung nach Einpflanzung des unteren Endes des Tränensacks in die Nase, Klin. Monatsbl. f. Augenh. **92**:433, 1934.

ever, there are many variations (Whitnall,[21] Thorsch [22] and Fazakas [23]). The nasal process of the maxilla, forming about the anterior half of the fossa, is thick and strong and becomes even thicker toward the anterior lacrimal crest, which curves downward and outward into the lower edge of the orbit, overlapping the lower end of the fossa in front. The lacrimal bone forming the posterior half of the fossa is thin, but it thickens slightly toward the posterior lacrimal crest. The upper half of the fossa and the lacrimal bone is related to the ethmoid air cells. In general, the line of the posterior crest may be taken as the posterior limit of entry into the nasal cavity. Within the nose, the anterior inferior end of the middle turbinate overlies the area of the lacrimal fossa. While all these features vary in different subjects, they show that the portion of the fossa directly related to the nose is limited to its lower half, behind the anterior lacrimal crest, an area measuring about 6 to 8 mm. in diameter. A satisfactory trepanation of the bone, in order to gain free access to the nose, must therefore extend downward and forward over the lower portion of the ascending process of the maxilla. The lower half of this bone is dense and contains no air cells.

In order to approach the nasal cavity by this avenue, the anatomic and pathologic variation of the nose must be considered; i. e., a high deviation of the septum causing obstruction must be corrected, and the anterior tip of the middle turbinate, if large and overhanging the area of trepanation, must be removed by a preliminary operation.

INDICATIONS

Mosher's [24] recommendation of dacryocystorhinostomy has been an important influence in the adoption of the external operation in this country. It would seem that the only objection to the external approach is the resulting scar. This minor cosmetic blemish is negligible when it is understood by both the patient and the surgeon that the external procedure affords a better view of the operative field, easier access to the nasal fossa through a more logical site and much less trauma to the

21. Whitnall, S. E.: (*a*) The Naso-Lacrimal Canal: The Extent to Which It Is Formed by the Maxilla, and the Influence of This upon Its Calibre, Ophthalmoscope **10**:557, 1912; (*b*) The Relations of the Lacrimal Fossa to the Ethmoidal Cells, Ophth. Rev. **30**:321, 1911.

22. Thorsch, E.: Beziehung der Tränensackgrube zur Nase und ihren Nebenhöhlen, Klin. Monatsbl. f. Augenh. **47**:530, 1909.

23. Fazakas, A.: Ueber die Topographie der Fossa sacci lacrimalis mit Rücksicht auf Operationen am Tränensack, Klin. Monatsbl. f. Augenh. **80**:775, 1928.

24. Mosher, N. P.: (*a*) The Mosher-Toti Operation on the Lacrymal Sac, Laryngoscope **31**:284, 1921; (*b*) Re-Establishing Intranasal Drainage of the Lacrymal Sac, ibid. **31**:492, 1921; (*c*) The Combined Intranasal and External Operation on the Lacrymal Sac, Ann. Otol. & Rhin. **32**:1, 1923.

intranasal structures. There are ophthalmologists who, while admitting that preservation or restoration of function is the surgical ideal, still prefer total extirpation of the lacrimal sac to any reconstructive procedure. Extirpation of the sac is indicated only for conditions in which reconstructive operations are contraindicated, such as trachoma, in which the cicatricial obstructions of the canaliculi and the sac may occur, tuberculous processes of the tear passages and malignant growths of this region. Intraocular operations, when postponed because of dacryocystitis, should be preceded by extirpation, unless it is possible to allow a few weeks to intervene between the two operations. The reason for this is clear. For purulent infections of the cornea in which there is constant reinfection from the sac, extirpation is desirable and in most instances imperative.

I feel that ophthalmologists should be thoroughly familiar with the various modifications of external dacryocystorhinostomy. Each modification has its proponents, but the question resolves itself into which method in a given case will give the best results with the least effort of execution. In operations on the lacrimal sac, as in all other surgical procedures, much depends on the skill and experience of the operator. An ophthalmologist limiting himself to his specialty must of necessity avail himself of the services of an experienced rhinologist. It is of importance that before deciding on any external operation for the relief of chronic dacryocystitis a careful examination of the nasal passages be made. As a preliminary step, any obstruction to a free communication must be corrected in every case; i. e., high deviations of the nasal septum must be resected, the anterior tip of the middle turbinate should be removed if so indicated, polypoid growths should be removed and any sinus disease should be controlled so far as possible. Many of the failures following efforts at dacryocystorhinostomy are not primarily due to any technical difficulties or faults of the operation but to neglect in dealing with preexisting pathologic conditions of the nose and paranasal sinuses.

There is no question that conservative treatment with lacrimal probes and syringes will sometimes cure early dacryocystitis in which stenosis is slight and in which a thickening of the wall of the sac has not occurred. But treatment by means of probes should cease soon after a few attempts have been found to be ineffective. The slitting of the canaliculus for the purpose of passing probes is not to be recommended, because it tends to destroy the natural capillary and suction mechanism at the proximal end. A slit canaliculus may nullify the otherwise good result of dacryocystorhinostomy (see case reports).

The final treatment of chronic dacryocystitis with obstruction in the bony canal and mucocele formation must be operative. The decision as to what method to use rests on the location and degree of obstruc-

tion encountered, the condition of the lacrimal sac itself, the presence of disease in the surrounding tissues and the existence of any nasal pathologic process.

TECHNIC OF IMPLANTATION OF LOWER END OF THE TEAR SAC INTO THE NOSE

Anesthesia.—All operations except those for children are done under local anesthesia in order to give a drier operative field. Anesthesia is secured as follows: Before the operation the patient is given from ¼ to ⅛ grain of morphine (16 to 8 mg.) and from 1/200 to 1/400 grain of scopolamine (0.325 to 0.16 mg.), depending on the age and weight of the person. The nose is anesthetized with packing saturated with a solution of cocaine hydrochloride and of epinephrine hydrochloride,

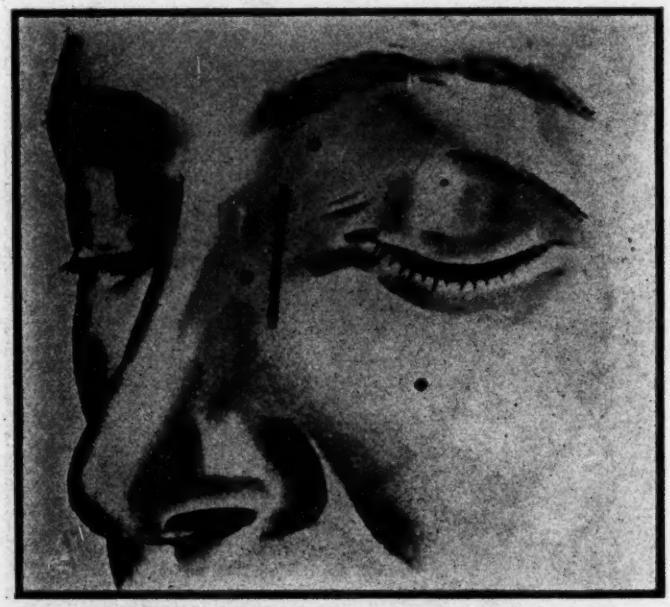

Fig. 1.—The nose is anesthetized with packing saturated with a solution of cocaine hydrochloride and epinephrine hydrochloride. A 1 per cent solution of procaine hydrochloride with a solution of epinephrine hydrochloride is injected under the skin along the line of incision. A second injection is made to block the anterior ethmoid nerve. The third injection blocks the infraorbital nerve. The incision is placed halfway between the inner canthus and the side of the nose.

care being taken to place the packing well up to the level of the sac. A 1 per cent solution of procaine hydrochloride with a solution of epinephrine hydrochloride is injected under the skin along the line of incision and also subperiosteally in this region. About 2 cc. of a solution of procaine hydrochloride is also injected close to the bone and well back along the inner orbital wall above, to block the anterior ethmoid nerve and branches of the infratrochlear and supratrochlear nerves. Another injection is made in the region of the infraorbital foramen (fig. 1). This procedure gives practically perfect anesthesia. If ether anesthesia

is used, the cornea should be carefully protected during the operation. If local anesthesia is employed, the eye is not cocainized, so that the patient will keep the eyelids closed or will wink frequently enough to prevent drying. The lower canaliculus is dilated sufficiently with a conical probe to allow the passage of a cannula, and the lacrimal sac is syringed with physiologic solution of sodium chloride.

Incision.—The incision is placed halfway between the inner canthus of the eye and the side of the nose, at least 12 mm. from the inner canthus (Mosher). It begins on a level with the summit of the globe and is carried downward in a nearly straight line, from 1.5 to 2 cm. in length. The incision is made down to the bone throughout its whole length. Retractors are inserted and held by an assistant, who also checks any bleeding by means of a small suction cannula (figs. 1 and 2).

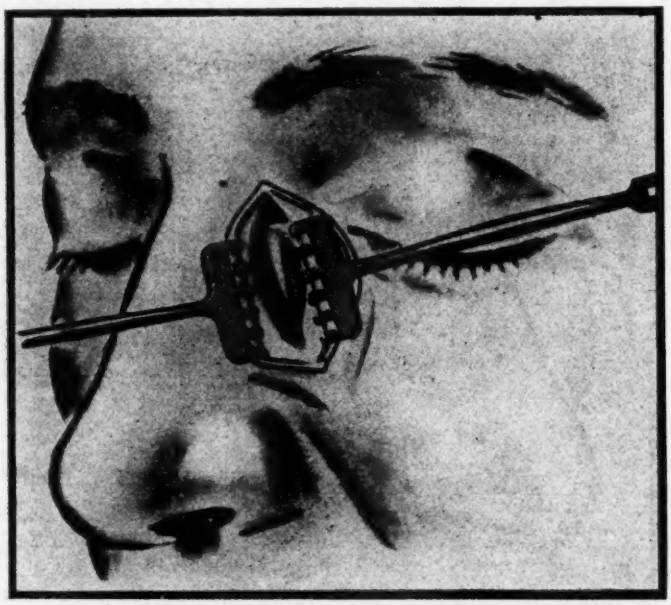

Fig. 2.—The attachment of the anterior limb of the "Y" ligament is divided, exposing the sac.

Elevation of the Periosteum and Exposure of the Sac.—With a small flat chisel the bone is exposed over the ascending process of the maxilla toward the anterior lacrimal crest. With a dissector, the edge of the anterior lacrimal crest is defined, and the attachment of the anterior limb of the Y ligament is divided, exposing the sac (fig. 2). The periosteum lining the fossa, together with the sac, is pushed outward, exposing the surface of the fossa almost as far back as the posterior lacrimal crest. The periosteum is separated downward as far as possible into the mouth of the nasolacrimal canal. The exposed fossa is carefully inspected for the presence or absence of a pathologic process in the bone. The sac is freed down to the entrance of the canal in its entire circumference and is cut completely across as far down as possible. The patency of the lower end of the sac is determined; if it is closed, it must be incised and opened with scissors. Two or three silk sutures are then introduced through the mucosa and the wall of the

sac about 1 to 2 mm. from the cut edge; the sac is lifted upward and protected with a flat retractor. The lacrimal fossa and the adjacent bony structures are now in view (fig. 3).

Perforation of the Bone.—A trephine 8 to 10 mm. in diameter is applied to the bone toward the lower part of the ascending process of the maxilla and should be directed slightly downward and as nearly as possible at right angles to the plane of the intranasal surface. The bony opening includes part of the anterior lacrimal crest and lacrimal sulcus anterior to where the superior maxilla unites with the lacrimal bone. The window thus made should lie almost entirely in the nasal process of the superior maxilla. Since the bone is much thicker in front than behind, the trephine must penetrate more deeply anteriorly. In order to prevent slipping, a trephine with a center pin must be used. It is well not to drill the hole too far upward or too far backward, as air cells may be

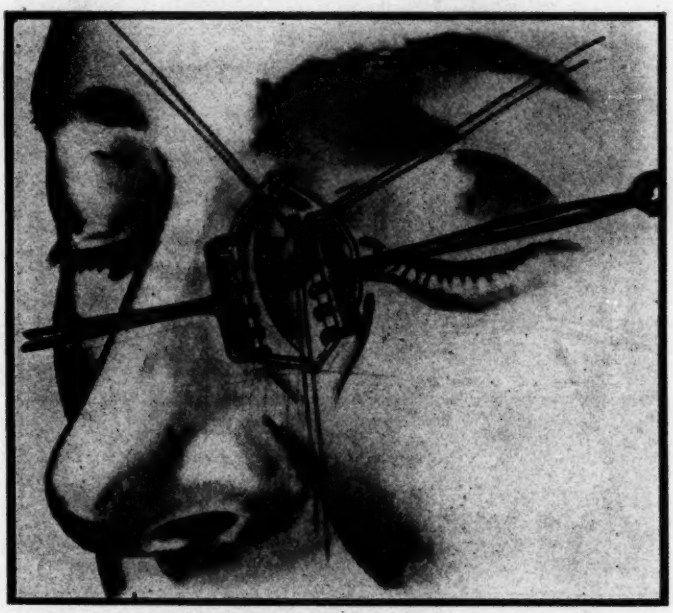

Fig. 3.—The sac is freed to the entrance of the canal and is cut completely across, as far down as possible. Three silk sutures are introduced through the wall of the sac about 1 to 2 mm. from the cut edge.

encountered. The trephine in use is actuated by an electric motor, and care must be taken to protect the soft tissues. This is best accomplished by the introduction of lid retractors, which will hold the soft tissues and the sac from the field of the rapidly revolving drill (fig. 4). After perforation, the bone and corresponding nasal mucous membrane are removed. The nasal mucous membrane is trimmed flush with the edges of the opening in the bone. The packing is withdrawn from the nose, and a spatula is passed through the nostril to insure that the opening is free with no tags of mucous membrane overhanging. A good-sized probe is passed through the old nasolacrimal duct, and the mucous membrane in this canal is destroyed by means of a curet.

Implantation of the Sac.—The ends of the silk sutures which are holding the lower end of the sac are passed through the new opening into the nose and are

picked up with a pair of nasal forceps. This is not difficult, because the new opening is not under the middle turbinate but is slightly anterior to its anterior end (fig. 5). The sutures, drawn through the nostril, hold the sac in the new bony canal. The sutures are held in place on the side of the cheek with adhesive tape (fig. 6). Possibly it would be better to tape the sutures on the opposite cheek for more direct traction. A small plug of gauze is inserted into the nostril and may be changed on the second day to avoid odor.

Skin Suture and Dressing.—An imperceptible scar is obtained if the muscles and fascia are sutured with fine catgut. The skin over it is carefully approximated with horsehair, a subcuticular type of stitch being used. Pads of gauze saturated with petrolatum are now placed over the incision, and a firm pressure bandage is applied.

Fig. 4.—A trephine 8 to 10 mm. in diameter with a center pin is applied to the bone toward the lower part of the ascending process of the maxilla.

After-Care.—The patient remains in bed for the first day but is allowed up on the second. On the fourth day the stitch in the skin is removed. On the sixth day the sutures in the sac are withdrawn, and the canaliculus is irrigated with physiologic solution of sodium chloride. The pressure bandage is now left off. For a week more the new passage is irrigated daily with physiologic solution of sodium chloride. Probing is not necessary and may actually do harm.

RESULTS

In 1935 I [25] made a preliminary report on the transplantation operation, and up to the time of writing 42 consecutive operations have

25. Stokes, W. H.: Refinements in Tear Sac Surgery, Nebraska M. J. **20**:388, 1935.

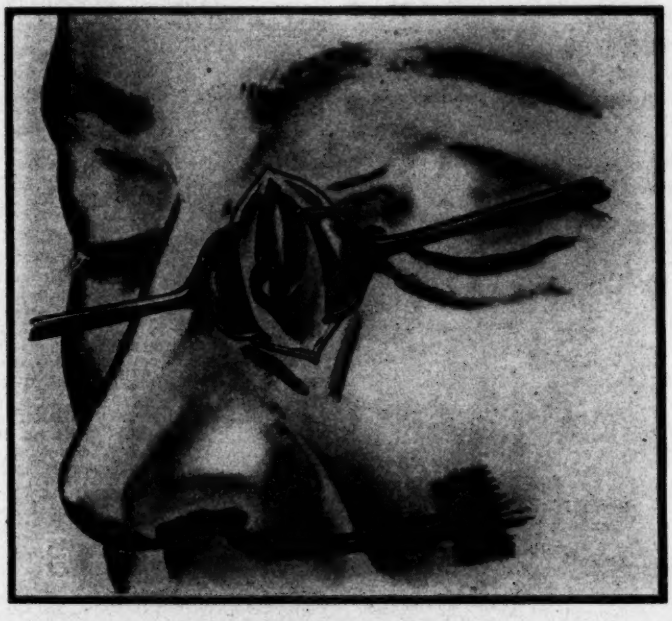

Fig. 5.—The sutures, drawn through the nostril, hold the sac in the new bony canal. The sutures are held in place on the side of the cheek with adhesive tape. For the purpose of direct traction it is better to tape the sutures on the opposite cheek.

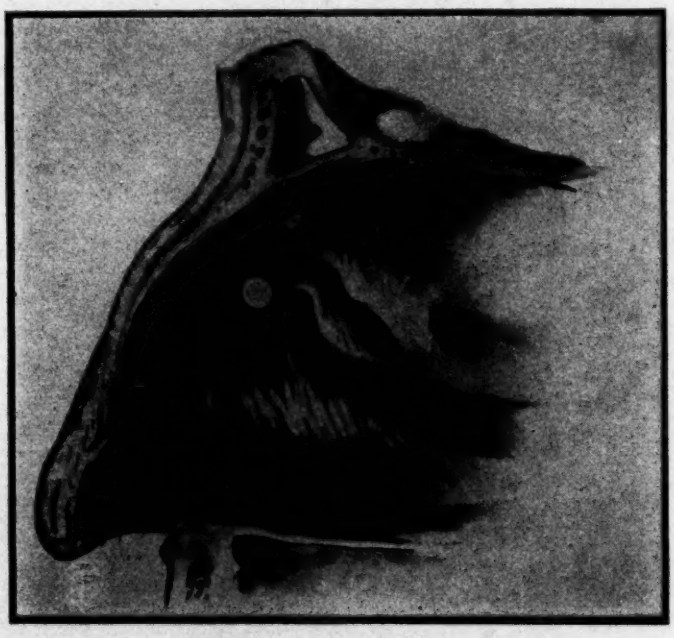

Fig. 6.—The new opening is not under the middle turbinate but is slightly anterior to the anterior end of the middle turbinate.

Case No. and Patient	Sex and Age	History and Treatment Elsewhere: Eye	Duration	Tearing	Secretion Expressed	Swollen Sac	Acute Dacryocystitis	Fistula	Probing	Operation	Slit Punctum
1 E. J. H.	M 58	L	3 to 4 yr.	+	+	+	0	0	+ 2 yr.	0	0
2 E. E. B.	F 56	L	Many years	+	+	+	0	0	+ 1 yr.	0	0
3 M. E.	F 71	R	Many years	+	+	+	0	0	+ 3 yr.	0	0
4 H. E. F.	M 64	R L	2 yr.	+ O. U.	+ O. U.	+ O. U.	+ R 3 mo. before second operation	+ R	2 yr.	Incision for phlegmonous dacryocystitis of right eye 3 mo. before second operation	0
5 G. D. Negro	F 40	R	6 mo.	+	+	+	+ 2 wk. before second operation	+	Several times	Incision for phlegmonous dacryocystitis 2 wk. before second operation	0
6 L. S.	F 35	R	Several years	+	+	0	+ 2 mo. before second operation	+	+ Many times	Incision for phlegmonous dacryocystitis 2 mo. before second operation	0
7 K. C.	F 60	L	Several years	+	+	+	0	0	+ Several times	0	0
8 M. R.	F 6	L	Several years	+	Small amount	0	0	0	+ Many times	0	0
9 J. M.	M 7	R	Several years	+	+	0	+ 1 mo. before second operation	+	0	Incision for phlegmonous dacryocystitis 1 mo. before second operation	0
10 W. F. P.	F 40	L	1 yr.	+	+	+	0	0	+ Several times	0	0
11 V. B.	F 37	L	Several years	+	+	+	0	0	+	0	0
12 W. R.	M 43	R	1 yr.	+	+	+	0	0	0	0	0
13 P. P.	F 30	R	12 mo.	+	+	+	0	0	0	0	0
14 E. H.	F 67	L	4 yr.	+	+	+	0	0	+	0	+ For probes
15 O. S.	F 63	R	For years	+	+	+	0	0	+ Many times	0	0
16 W. C.	M 45	R	Several years	+	+	+	0	0	0	0	0
17 S. M.	F 52	L	3 yr.	+	+	+	0	0	0	0	0
18 J. H.	M 13	L	1929	+	+	+	0	0	33 times in 2 yr., no. 9 probe	0	+ For probing
19 J. K.	F 48	R	15 mo.	+	+	Looked like tumor	0	0	0	0	0
20 E. M. C.	M 61	R L	3 yr. in each eye	+	+	+	1 yr. before second operation in each eye	+ R	+	+ For acute dacryocystitis 1 yr. before second operation	0
21 T. M. R.	F 62	R	12 mo.	+	+	0	+ 1 mo. before second operation	+	0	+ For acute dacryocystitis 1 mo. before second operation	0 0

Examination and Operation				Results and Follow-up Study		
Position of Obstruction	Condition of Nose	Date of Operation	Findings at Operation	Tearing	Results	Period of Observation Since Operation
Bony canal	Good	6/ 6/34	Large mucocele	0	Good in 1938	4 years
Bony canal	Good	12/29/34	Large mucocele	0	Good in 1938	3 years and 6 months
Bony canal	Good	1/23/35	Large mucocele	0	Good in July 1936; patient died later	1 year and 6 months
Bony canal	Good	O.D. 2/17/35 O.S. 2/27/35	Large mucocele in each eye	0	Good in each eye in 1938	3 years
Bony canal	Good	3/27/35	Fistula	0	Good	3 years
Bony canal	Good	8/17/35	Mucocele; fistula	Some at first	Good	3 years
Bony canal	Good	9/17/35	Mucocele	0	Good	2 years; death
Bony canal	Good	9/25/35	Atrophic sac; peridacryocystitis	+	Failure; Toti-Mosher operation 7/25/36; sac obliterated	Failure; did not irrigate through
Bony canal	Good	10/19/35	Mucocele; fistula	0	Good	2 years and 6 months
Bony canal	Good	1/22/36	Mucocele	0	Good	1 year and 4 months (patient moved away)
Bony canal	Good	2/13/36	Mucocele	0	Good	2 years and 6 months
Bony canal	Good; a few polyps removed	2/29/36	Mucocele	0	Good	2 years and 4 months
Bony canal	Large middle turbinate; should have anterior two-thirds removed	3/18/36	Mucocele	+	Failure 5/10/37	Opening under middle turbinate closed; patient refused to have anything further done
Bony canal	Good	5/25/36	Mucocele	+	Good	2 years; eye still waters a little
Bony canal	Good	7/29/36	Mucocele	0	Good	2 years
Bony canal	Good	7/ 6/36	Mucocele	0	Good	2 years
Bony canal	Good	9/ 1/36	Mucocele	0	Good	1 year and 10 months
Bony canal	Good	9/13/36	Mucocele	+ Slit punctum	Good	1 year and 10 months
Bony canal	Good	11/ 5/36	Mucocele	0	Good	1 year and 8 months
Bony canal	Good	O.D. 3/ 1/37 O.S. 3/ 8/37	Fistula; mucocele	0	Good	6 months; excellent
Bony canal	Deviated septum; large middle turbinate	4/27/37	Small mucocele	+	Failure (in 1 mo.)	Should have had tip of middle turbinate removed

Case No. and Patient	Sex and Age	History and Treatment Elsewhere: Eye	Time Onset; Duration	Tearing	Secretion Expressed	Swollen Sac	Acute Dacryocystitis	Fistula	Probing	Operation	Slit Punctum
22 V. W.	M 26	L	3 yr. trauma	+	+	+	0	0	0	0	0
23 P. L.	F 46	R	Many years	+	+	+	+ 6 mo. before second operation; University Hospital	+	0	+ Incision for acute dacryocystitis 6 mo. before second operation	0
24 I. S.	F 56	R	10 yr.	+	+	+	0	0	+ Several times	0	0
25 W. W.	F 56	L	Several years	+	+	+	0	0	+ Many times	0	0
26 R. S.	M 18	R	1 yr. trauma	+	+	+	0	0	0	0	0
27 L. F.	F 63	R	1 yr.	+	+	+	+ 2 wk. before second operation; University Hospital	+	+ Many times	Incision for acute phlegmonous dacryocystitis 2 wk. before second operation	+
28 F. H. W.	F 49	L	Many years	+	+	+	+ 5 mo.	+	+ Many times	Incision for acute phlegmonous dacryocystitis 5 mo. before second operation	0
29 C. A.	F 19	R	Since childhood	+	+	+	0	0	+ Once a wk., past 2 yr.	0	0
30 M. L.	F 24	R	Since childhood	+	+	+	0	0	+ Many times	0	+ For probes
31 E. E. M.	F 77	R	Years	+	+ by irrigation	0	0	0	Many times for several years	0	+ For probes
32 P. C.	F 54	R	Years	+	Small amount through upper canaliculus	0	0	0	+	0	+
33 M. J.	F 61	R	1 yr.	+	+	+	0	0	+	0	0
34 E. B.	M 10	R L	8 yr. trauma	+	+	+	0	0	Many times	0	0
35 D. R.	F 49	L	Several years	+	Through upper canaliculus	0	0	0	Many times	0	+ Lower canaliculus obstructed
36 D. S.	F 20	L	4 yr.	+	+	0	+ 4 yr. before operation; recurrence 5 times	+ 4 yr.	0	0	0
37 A. B.	M 81	R	2-3 yr.	+	Very little	0	0	0	+ Several times	0	0
38 E. J.	F 44	L	1 yr.	+	+	+	0	0	0	0	0
39 E. N.	F 31	L	Several years	+	+	+	+ Several times	0	+	Incision for acute dacryocystitis; done twice a year since 1936	0

Transplantation Operations on the Tear Sac—Continued

Examination and Operation				Results and Follow-up Study		
Position of Obstruction	Condition of Nose	Date of Operation	Findings at Operation	Tearing	Results	Period of Observation Since Operation
Bony canal	Good	6/16/37	Mucocele	0	Good	1 year
Bony canal	Good	7/15/37	Mucocele; fistula	0	Good	1 year
Bony canal	Good	8/26/37	Mucocele	0	Good	1 year
Bony canal	Good	8/27/37	Mucocele	0	Good	1 year
Bony canal	Had submucous operation; anterior tip of middle turbinate removed 3 wk. prior to operation	9/10/37	Mucocele	0	Good	10 months
Bony canal	Good	9/17/37	Mucocele; fistula	+ Slit punctum	Good	10 months
Bony canal	Good	9/24/37	Mucocele; fistula	0	Good	10 months
Bony canal	Good	10/ 8/37	Large mucocele	0	Good	10 months
Bony canal	Good	11/ 4/37	Large mucocele	+ Slight; slit punctum	Good	8 months
Bony canal	Good	12/ 6/37	Mucocele	+	Good	8 months
Lower canaliculus closed; bony canal obstructed	Good	1/26/38	Atrophic sac	+	Irrigation readily obtained into nose through upper canaliculus	7 months
Bony canal	Good	2/ 4/38	Mucocele	0	Good	6 months
Bony canal	Good	O.D. 3/ 9/38 O.S. 3/12/38	Large mucocele in each eye	0	Good	5 months
Bony canal	Good	3/ 9/38	Mucocele	+	Good; through upper punctum	5 months
Bony canal	Good	4/ 4/38	Mucocele; fistula	0	Good; external fistula closed 1 mo. later with cautery	4 months
Bony canal	Good	5/11/38	Small mucocele	0	Good	3 months
Bony canal	Good	6/21/38	Mucocele	0	Good	3 months
Bony canal	Good	7/14/38	Mucocele	0	Good	2 months

been performed on 39 patients, 28 females and 11 males. Four of these were children between the ages of 6 and 13 years. The average age, exclusive of children, was 48 years. When the general condition warranted, operations were performed on several patients in the seventh decade. All were unselected patients with chronic dacryocystitis. Although a simple mucocele was present in the great majority of the patients, in 11 there had been one or more previous attacks of acute dacryocystitis, and an external fistula was present at the time of the operation in 10. In all patients the obstruction was low down in the bony canal, as determined by the introduction of a small probe.

All of the 39 patients complained of epiphora at the time of examination and had visible secretion in the conjunctival cul-de-sac; pus could be expressed by pressure over the sac. These symptoms had been in evidence for a number of years.

Previous treatment, before the patients were admitted to the ophthalmic clinic, had consisted of repeated probing for 26 patients, for some of them over a period of years, and the lower canaliculus of 7 patients had been slit for the purpose, apparently, of passing probes.

The period of observation, after transplantation had been performed, was from three months to four years, with an average of eighteen months in the 39 cases.

The criteria of success were the free passage of fluids into the nose and the absence of all symptoms referable to the lacrimal drainage apparatus. On follow-up study all patients were examined personally except 2, who replied by letter.

The 3 cases in which complete failure occurred are reported here.

CASE 8.—A girl, aged 6 years, at the time of the operation was found to have a small atrophic sac, stenosed at its lower end. All symptoms returned one month after operation. The child was reoperated on later, and the sac was found to be closed. A Toti-Mosher operation performed at this time cured the infection but did not restore drainage into the nose.

CASE 13.—A woman, aged 30, on examination of the nose before operation was found to have deviation of the septum. The middle turbinate was unusually large, and the anterior tip was overhanging the area of trepanation. The patient refused a nasal operation as a preliminary step. Trephining of the bone placed the opening underneath the tip of the middle turbinate, and adhesions closed the sac completely.

I feel that failure in this case could have been avoided by a submucous resection with removal of the anterior tip of the middle turbinate.

CASE 21.—A woman, aged 62, had an acute phlegmonous dacryocystitis which was treated in the usual manner, and at the time of the examination chronic dacryocystitis with the formation of a fistula was observed. The obstruction was

in the bony canal. The nose showed marked deviation of the septum, and the tip of the middle turbinate was overhanging the area of trepanation. The patient also refused preliminary nasal operation as a corrective measure.

The cause of failure was the same as in case 13 and could, perhaps, have been avoided.

Of the 39 patients, there were 7 who previous to entering the clinic had had their lower canaliculi slit for the purpose of passing probes. All of these 7 patients had some visible tearing months after an otherwise successful transplantation operation. An ideal result is therefore not achieved if the canaliculi have been slit. This, however, is not a fault of the transplantation operation.

CONCLUSIONS

1. In reporting this procedure an attempt has been made to take advantage of the best features of the previously reported technics of the transplantation operation, and a method has been developed which it is believed will reduce the failures to a minimum.

2. Any coexisting nasal pathologic process must be corrected as a preliminary step in the operation.

3. A patient with chronic involvement and a large sac from which a sizeable quantity of pus can be expressed on pressure is best suited for this operation.

4. Chronic dacryocystitis with the formation of a fistula is not a contraindication to this operation. The fistula closes in most instances as soon as drainage into the nose is reestablished.

5. None of the sac is sacrificed, and no cul-de-sac is left wherein infectious material may collect. Natural drainage clears up the infection in the sac.

6. Less bone is removed, and there are no flaps of mucous membrane to deal with. There is practically no reaction in the nose.

7. Not much more time is required for this operation than for a simple excision of the sac. It is the least difficult of all types of dacrocystorhinostomy.

8. Little or no after-treatment is required, and the *scar* is imperceptible.

DISCUSSION

Dr. Ralph O. Rychener, Memphis, Tenn.: I heartily concur with Dr. Stokes in finding no place for extirpation of the lacrimal sac save for malignant growths of that area. Dacryorhinostomy is logical even in cases in which one desires to do an intraocular operation at a later date, for the reestablishment of normal function permits drainage and the discharge of infected material into the nose. There are five generally accepted methods which are used for restoring physiologic action of the

lacrimal passageway in the treatment of chronic dacryocystitis, and in reviving the Speciale-Cirincione transplantation operation, Dr. Stokes has illustrated the fate of the other four which have likewise been advocated, discarded and then again revived on the strength of reports of modifications with successful results by later authors. The absence of unanimity of opinion as to the best technic means that most operators have encountered failures in their preferred procedures and have been induced to try other technics for establishing patency of the lacrimal passageway.

For the past three years I have been familiar with the operative technic described by Dr. Stokes. Quite satisfactory as it is in his hands, it does not seem to me to be a procedure which is suitable for every case of chronic dacryocystitis. By his own operative results, he has established that it is ineffective in the case of the small atrophic sac. It will not suffice for sacs which are obstructed by papillomas, nor will it be satisfactory for lacrimal obstructions following trauma of the face in which the area of the sac is involved by much scar tissue. One can, of course, outline the sac by the injection of a radiopaque substance and by roentgenograms determine whether the sac is suitable for transplantation; if it is not suitable, some other method of approach may be used.

Although my experience has not been as extensive as that of Dr. Stokes, I have used the Dupuys-Dutemps modification of the external operation since 1929 with satisfactory results. Twenty-seven operations have been done on 24 patients, and a successful result has been achieved in every instance. It has, therefore, been difficult for me to bring myself to try the transplantation procedure, for one hesitates to change a method which in his hands has been so satisfactory.

Dr. Frank E. Burch, St. Paul: Dr. Stokes again emphasizes conservation of the lacrimal sac versus extirpation and loss of physiologic function in drainage of the lacrimal passageway. His cases prove the virtue of the method he has employed, and his paper stresses the importance of anatomic relationship.

In making a new foramen into the nose, it is especially important that it be made low down and well forward, the anterior lacrimal crest being cut away through fairly thick bone. There is no doubt in my mind about the relative value of utilizing the upper end of the duct with the lower portion of the sac for purposes of drainage. The follow-up studies that I have been able to make in my own series (dacryocystorhinostomy) have shown the higher percentage of success to be obtained with patients in whom the thicker anterior portion of the crest has been thoroughly removed, including a goodly portion of the frontal process of the superior maxilla, the upper and posterior half of the lacrimal fossa being entirely avoided. Inadequate follow-up treatment is the cause of some failures.

TEMPERATURE CHANGES AND CHANGES IN CALIBER OF RETINAL BLOOD VESSELS AFTER SHORT WAVE DIATHERMY

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The general concept of the effect of fever has been markedly altered since Welch [1] in 1888 first lectured on the beneficial effects of increased body temperature. It is now well recognized that the defense mechanism of the body is stimulated by increased temperature, and in many diseases an attempt has been made to aid physiologic processes by producing artificial fever. Although many methods have been advocated for temporarily increasing the thermal level of the body, nevertheless the greatest impetus to the study of hyperpyrexia came with the discovery that high frequency currents were capable of producing heat in living structures. This finding was originally made by d'Arsonval in 1893, but the clinical significance was not recognized until the more recent studies of Hosmer [2] and the clinical reports of Neymann and Osborne [3] and later of Carpenter.[4]

As Coulter and Osborne [5] have pointed out, this heating of the tissues by means of high frequency current has been termed diathermy. There are many different gradations of heating, and the lower level, or that within physiologic limits, is known as medical diathermy. Surgical diathermy is the term used to designate actual destruction of tissue by means of coagulation. In the pioneer stage of diathermy the instruments were all of the 300 to 400 meter type, but the recent

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1. Welch, W. H.: M. News **52**:365, 1888.
2. Hosmer, H.: Science **68**:328, 1928.
3. Neymann, C. A., and Osborne, S. L.: Illinois M. J. **56**:199, 1929.
4. Carpenter, C. M.: Phys. Therapy **48**:264, 1930.
5. Coulter, J. S., and Osborne, S. L.: Principles and Practice of Physical Therapy, Hagerstown, Md., W. F. Prior Company, Inc., 1936, vol. 3.

development of the oscillator tube has made possible the production of much shorter wavelengths, and now the wavelengths vary from 6 to 30 meters. This change in generators has brought with it both advantages and new technics, and conventional diathermy is now almost completely superseded by short wave diathermy.

In the field of ophthalmology numerous pathologic conditions have been treated by conventional diathermy, as shown in the report of Nugent.[6] The clinical and experimental application of short wave diathermy, however, has received only little attention, and practically no attempt has been made to follow a study program for the purpose of determining, if possible, the standardization of dosage, the extent and duration of heating and the dangers associated with this form of treatment. In this work we have directed our attention toward clarifying the answers to some of these questions with the hope of establishing a better understanding of this problem.

HISTORICAL REVIEW

Kiewe[7] in 1935 reported three series of experiments in which the Sanitas Undula B 8 to 10 meter instrument was used. In the first two series heating and cooling curves were made on isolated aqueous, vitreous and freshly enucleated pig and calf eyes. In all of these experiments there was almost uniform heating, and this he attributed to an equal resistance throughout the tissues. In the third series living rabbits were submitted to short wave radiations; the greatest increase in temperature was recorded at the posterior pole. In summarizing this work, Kiewe was skeptical of the use of short wave diathermy because of the difficulty in regulating the dosage.

Grüter[8] used the same apparatus clinically with heat treatment varying from twenty to twenty-five minutes. One electrode (size recommended by Raab) was placed over the eye and the other below the occiput. Good results were obtained in a series of 22 cases of serpent ulcer in which heat treatments were administered three to four days in succession. Superficial ulcers healed in from five to six days, leaving only a slight scar. Good results were also reported in 41 cases of herpes corneae. Many of the patients showed increased edema and swelling of the iris and corneal tissues immediately after the heat treatment, but these reactions diminished markedly during the days that followed. Grüter was of the opinion that scarring occurred more rapidly and the recurrence of ulceration less frequently.

6. Nugent, O. B.: Arch. Phys. Therapy **17**:37, 1936.
7. Kiewe, P.: Klin. Monatsbl. f. Augenh. **95**:108, 1935.
8. Grüter, W.: Klin. Monatsbl. f. Augenh. **95**:605, 1935.

De Decker and Arendt [9] were equally impressed with the results secured with the Siemen 6 meter ultratherm. In treating their patients the Schliephake glass electrodes were placed approximately 1 cm. from the surface of the skin with one 4 cm. electrode over the eye and the larger, or indifferent, electrode over the lateral side of the face. The instrument was set at a potential difference of 19 to 20 volts. No cerebral symptoms or burns occurred, and especially good results were observed in cases of herpes and of old corneal opacities. De Decker confined the contraindications to arteriosclerosis because of the possible cerebral symptoms and complications.

Kokott [10] in 1936 reported experiments on two series of animals, the Siemen 6 meter ultratherm being used in the investigation. For the first series a 2 cm. Schliephake glass electrode was placed over the eye, and the following temperature changes were noted: in the vitreous, an increase of 0.6 degree F. at the end of six minutes, of 2.3 degrees at the end of ten minutes and of 3 degrees at the end of fifteen minutes; in the orbital fat, an increase of 2.8 degrees at the end of fifteen minutes. The vitreous of all these animals was found to be warmer than the surrounding structures. For the second series, the temperature of the vitreous increased 1.8 degrees at the end of five minutes and 4.8 to 5 degrees at the end of fifteen minutes. These temperature changes were accompanied by an increase of 2.9 degrees in the orbit with a rise of 1.2 degrees in the rectal temperature.

Gutsch [11] also used the Siemen 6 meter ultratherm, and the Schliephake glass electrodes were placed 1 to 3 cm. from the eye. With a series of 276 patients no results were secured in those with corneal infections, but those with iridocyclitis, especially of the tuberculous type, showed definite improvement, precipitates quickly disappearing and the opacities of the vitreous clearing up. Surprisingly good results were observed in patients with acute purulent inflammation of the orbit and lacrimal sac. The treatments were thought to be of value for paralysis of the muscles and for supraorbital neuralgia.

The effect of short wave diathermy on trachoma has been studied by Busse-Grawitz.[12] Good results were reported in a number of cases in which daily irradiations of ten minutes' duration were given.

The best results reported by Grosz [13] were obtained in cases of acute purulent disease of the lacrimal apparatus, lids and orbit. The Brevix II 6 to 12 meter apparatus was used in his clinical work, with

9. de Decker, J. F., and Arendt, J.: Klin. Monatsbl. f. Augenh. **95**:462, 1935.
10. Kokott, W.: Klin. Monatsbl. f. Augenh. **97**:448, 1936.
11. Gutsch, W.: Ber. u. d. Versamml. d. deutsch. ophth. Gesellsch. **51**:221, 1936.
12. Busse-Grawitz, P.: Arch. f. Schiffs- u. Tropen-Hyg. **40**:520, 1936.
13. Grosz, I.: Orvosképzés **27**:94, 1937.

each treatment varying from five to ten minutes. No apparent improvement was observed in cases of blepharitis, chronic dacryocystitis, degeneration of the cornea and retina, cataract, optic neuritis and old choroiditis.

Heating in enucleated eyes occurs independent of the position of the electrodes so long as their spacing remains the same, according to the work of Krause.[14] In his experiments on human beings he placed one 5 cm. Schliephake electrode over the temple and another over the eye. Larger electrodes were used for treating infections of the tear sac and similar infections, but in these cases he found it necessary to place the electrodes much farther from the surface of the skin. Good results were secured in cases of infection following cataract extraction. In such cases seven twenty minute heat treatments were used with the instrument set on a wavelength of 4 meters. In a number of his patients a slight hemorrhage occurred after the third treatment, but this absorbed without damage to the eye. No results were secured in cases of disciform keratitis or of herpes corneae. The response of infection of the lids, styes and abscesses varied, although most of them were cured within two to three days if the treatment was initiated at the onset.

After some experimentation on animals, Klein and Bányai[15] concluded that burns can be eliminated by depending on the patient's sense of heat. For acute inflammation, the treatments were continued from four to eight minutes, with the dose kept low enough to avoid any sensation of heat. The duration of treatment for chronic conditions was from five to fifteen minutes, a 4 cm. Schliephake electrode being used, 3 to 5 cm. in front of the eye and a 5 cm. electrode 8 to 10 cm. from the skin over the occiput. A total of 121 patients was treated, including 18 with inflammation of the lids, orbit and lacrimal apparatus; 95 with inflammation of the anterior segment, and 8 with choroiditis, retinitis and hemorrhages of the retina and vitreous. In all cases the treatment was well tolerated, and subjective symptoms were nearly always improved. The greatest improvement was observed in cases of pyogenic processes of the lids and orbit, while retinal hemorrhages appeared to clear more rapidly after treatment.

Hausemann[16] performed some experimental work before applying short wave therapy clinically. In her series of experiments on rabbits harmful changes were never observed during a period of six months. A total of 31 patients was treated by her in the eye clinic in Vienna. The Elektrodyne 3 meter, 40 to 50 watt instrument was used, with the

14. Krause, J.: Ztschr. f. Augenh. **80**:266, 1936.

15. Klein, M., and Bányai, G.: Ann. di ottal. e clin. ocul. **65**:705, 1937; abstracted, Arch. Ophth. **20**:679 (Oct.) 1938.

16. Hausemann, G.: Ztschr. f. Augenh. **93**:213, 1937.

electrodes placed 3 to 4 cm. from the eye. Treatments of ten to fifteen minutes were arbitrarily selected with intervals varying from twenty-four to forty-eight hours. All of the patients received the customary local treatment, and this made it difficult to evaluate the actual response to short wave therapy. No ill effects were observed, and in no case was there any change in intraocular tension or caliber of the vessels. There were 5 cases of postoperative infection. In 3 of these the hypopyon disappeared within two days after the application of short wave therapy. Benefit was obtained in only 2 of 9 cases of perforating injury, and a favorable effect was observed in only 1 of 7 cases of chronic uveitis. Of 6 cases of serpiginous ulcer, an excellent response was obtained in only 3, while healing occurred in 2 cases of herpes corneae after fourteen days of treatment. The best results were secured in 2 cases of acute dacryocystitis, response being obtained after only a few applications of heat. Hausemann considered short wave diathermy a pleasant type of treatment for the patient and of real value in purulent and postoperative infections and in diseases of the choroid.

A number of microscopic studies have been made following the controlled use of heat. Plitas [17] put a series of dogs and cats in a heating chamber and raised its temperature from 35 to 70 C. for two to three hours each day during a thirty-five day period. Ophthalmoscopically the animals showed some hyperemia of the fundus with a separation of the cortex from the anterior lens capsule (artefact?). The ganglion layer was affected most in the retina. These changes, resembling those found in the central nervous system, consisted in a lessening of the Nissl substance with tigrolysis. There was also some shrinking of the nuclei with vacuolation of the ganglion cells.

Hoffmann and Kunz [18] have demonstrated that temperatures of 45 C. are injurious to the eye. They applied hot water (approximately 65 C.) directly to the eye, and made temperature readings with a thermocouple and galvanometer. Additional experiments were performed with their own electrode and conventional diathermy apparatus, with the current varying from 150 to 350 milliamperes. In their animals "thermal temperature cataracts" were formed by a swelling and decomposition of the fibers under the lens capsule. They were able to limit this reaction to the subcapsular fibers by keeping the current well within the specified dosage. Hyperemia, hemorrhage and albumin formation frequently occurred in the retina, iris and ciliary body, which reactions were caused by circulatory changes. The epithelium was more affected than the connective tissue, while in the retina the innermost layers gave evidence of the greatest injury.

17. Plitas, P.: Arch. f. Ophth. **131**:458, 1933.

18. Hoffmann, W., and Kunz, E.: Arch. f. Ophth. **132**:155, 1934.

A specific dilator effect of short wave diathermy on the retinal vessels has been claimed in several reports. Carlotti, Jacquet and Roland [19] constructed an 18 meter, 1/10 watt, unipolar instrument of their own and administered a dose equivalent to one ten-thousandth of the amount frequently used for treatments with electropyrexia. This amount of energy was not great enough to produce fever, but the intraocular tension decreased and a dilatation of the retinal vessels was reported in all of the cases.

Trovati [20] studied the effect of short wave diathermy on a series of 10 patients with normal intraocular tension. For the first group of 4 patients the 250 watt, 30 meter Siemen radiothermy instrument was used with two 8 by 10 cm. electrodes placed on each side of the head. The intensity of the current was placed at 2 amperes. Ophthalmoscopic observations were made at the end of two ten minute heating intervals, and a dilatation of both the arteries and the veins was reported in all of the patients. Similar findings were noted in the second group for whom a 1,000 watt, 8 meter instrument was used. Neither Trovati nor Carlotti and his co-workers have presented photographic proof of these changes in caliber of the vessels.

Most of these articles that have been briefly reviewed are open to the criticism that only a few of them contain sufficient evidence to prove that heating actually occurred. If short wave diathermy is to be appraised as to its value in ophthalmology, an attempt must be made to supplement personal opinions with temperature readings and other forms of proof. Short wave diathermy certainly offers little in the way of treatment of herpes corneae, if it requires fourteen days (Hausemann) to produce noticeable improvement.

EXPERIMENTAL STUDY

In the following experiments we have studied: (1) the heating of the conjunctiva, vitreous and orbit; (2) the histologic changes which occur following the administration of heat, and (3) the effect of heat on the caliber of the retinal vessels.

As a guide to general body temperature, temperature measurements were also taken in the abdominal cavity. All these measurements were made by means of a thermocouple, a description of which will be given later. Cooling curves were made after the termination of the application of heat.

The retinal vessels were calibrated by photographing them before and after the heat treatments.

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19. Carlotti, M.; Jacquet, and Roland, M.: Rev. d'oto-neuro-opht. **14**:260, 1936.
20. Trovati, E.: Ann. di ottal. e clin. ocul. **64**:603, 1937.

Technic.—The 6 meter ultratherm short wave diathermy instrument was selected for parts 1 and 2 of this work. This instrument was chosen because other investigators had used it, and we wished to duplicate their technic. The temperature readings were taken with a thermocouple made of copper and constantan wire and soldered into the tip of a 16 gage lumbar puncture needle. This thermocouple, which was connected directly to a Leeds Northrup portable precision type potentiometer, was calibrated against a thermometer calibrated by the Bureau of Standards of the United States Department of Commerce. The thermal levels were determined by inserting the needle directly into the subconjunctival tissue, vitreous, orbit and abdominal cavity. Control readings were made just prior to each experiment, and additional readings were made at the end of the ten or twenty minute heat period and at regular intervals throughout the rest of the experiment.

Two inch (5 cm.) Schliephake glass electrodes were used with the following positions for applying the heat: (1) one placed 2 inches from the eye and the other 2 inches from the skin at the back of the neck, and (2) one placed on each side of the eye 2 inches from the skin with an electrode to electrode distance of 5 inches (12.7 cm.).

These different positions were selected to determine if it were possible to localize the temperature to the eye. A special attempt was made to keep a constant electrode to skin and electrode center to center distance. The voltage potential as given on the voltage meter was likewise recorded in each experiment.

Twenty-one healthy dogs were used during the course of this study. All of the treatments and operative procedures were performed with the dogs under anesthesia with pentobarbital sodium. Seven of the dogs were saved for observation, and the eyes were enucleated on the seventh to the fourteenth day. No attempt was made to secure ocular temperatures in this group, because we did not want to damage the eyes. However, abdominal temperatures were taken before and after the treatments, and these can be used as a means of estimating the ocular temperature when they are interpolated in terms of the average graph.

There were 11 dogs studied in the series in which one 2 inch electrode was placed over the back of the head and another 2 inch electrode over the eye. Seven of these animals were irradiated for twenty minutes at 20 to 22 volts, and the remaining 4 received only a ten minute treatment but at the maximum voltage (22 volts).

Results.—Tables 1 and 2 contain the individual records, but for the sake of simplicity the average findings have been charted in figures 1 and 2. These graphs indicate that the temperatures of the subconjunctiva, vitreous, orbit and abdomen bear definite relation to each other during heating and cooling. The average initial temperatures varied in both groups, but the order of greatest heating was: vitreous, 107.8 F.; subconjunctiva, 107.3 F.; orbit, 105.5 F., and abdomen, 105.1 F., respectively.

The loss of heat in the vitreous and subconjunctiva was great during the first five minutes of cooling. The average graph for group 1 (table 1, fig. 1) shows the following decreases in temperatures during the first five minutes: vitreous, 3.8 degrees F.; subconjunctiva, 4.0 degrees; orbit, 1.8 degrees, and abdomen, 1.1 degrees. This indi-

TABLE 1.—*Temperature Readings Before and After Twenty Minute Heat Treatment* *

Dog No. and Weight	Voltage	Onset of Panting	Temperature Readings	Before Treatment	After Treatment							
				0′	21′†	25′	30′	35′	40′	50′	60′	70′	80′
1	22	15′	Subconjunctiva	99.1	107.6	103.3	103.0	102.7	102.3	101.8	101.7	101.8	101.7
20 lb.			Vitreous	99.4	108.0	103.3	102.7	102.1	101.9	101.7	101.6	101.6	101.5
(9.1 Kg.)			Orbit	100.4	105.2	102.5	102.7	102.9	102.7	102.3	102.0	102.0	102.4
			Abdomen	100.8	106.0	103.3	104.5	103.8	103.6	103.3	103.3	103.2	103.1
2	22	14′	Subconjunctiva	100.0	110.3	106.1	105.2	104.3	103.4	101.8	100.6	99.8	99.1
20 lb.			Vitreous	100.4	109.9	106.0	105.2	104.4	103.7	102.2	101.2	100.2	99.2
(9.1 Kg.)			Orbit	101.4	107.7	106.2	104.9	103.7	103.5	102.2	101.1	101.1	101.1
			Abdomen	102.3	109.0	107.8	107.6	106.5	105.4	105.1	104.9	104.7	104.4
3	20	15′	Subconjunctiva	99.2	107.3	104.0	103.3	102.5	102.5	102.4	102.5	102.5	102.6
17 lb.			Vitreous	100.0	109.4	104.7	104.2	103.7	103.5	103.2	103.1	103.0	102.8
(7.7 Kg.)			Orbit	101.6	106.4	104.8	104.9	104.2	104.0	103.7	103.6	103.4	103.2
			Abdomen	102.3	106.1	105.3	104.9	104.6	104.3	104.0	103.7	103.3	103.0
4	20	19′	Subconjunctiva	98.8	105.2	101.3	100.0	100.1	100.3	100.1	99.6	99.6	99.6
20 lb.			Vitreous	98.8	105.6	102.2	100.6	100.1	100.0	99.8	99.6	99.4	99.6
(9.1 Kg.)			Orbit	99.5	103.6	101.6	101.3	100.8	100.7	100.4	100.0	99.8	99.6
			Abdomen	99.9	102.0	101.8	101.8	101.5	101.4	101.1	100.8	100.6	100.5
5	20	17′	Subconjunctiva	99.9	109.8	104.3	102.6	101.9	101.3	100.2	99.4	99.7	100.0
25 lb.			Vitreous	100.7	108.7	105.2	103.4	102.9	102.4	101.6	100.8	101.6	101.3
(11.3 Kg.)			Orbit	100.6	106.8	104.3	103.5	102.9	102.2	101.7	102.0	101.6	101.3
			Abdomen	101.8	104.3	104.2	104.2	104.0	103.7	103.3	102.8	102.6	102.4
6	20	15′	Subconjunctiva	100.4	108.5	104.3	103.4	103.2	103.0	102.9	103.0	102.8	102.6
27 lb.			Vitreous	101.3	109.1	105.1	103.4	103.3	103.1	102.9	102.9	102.3	101.6
(12.2 Kg.)			Orbit	102.0	105.3	104.7	103.6	103.5	103.5	103.4	103.1	103.1	103.1
			Abdomen	103.5	105.1	104.9	104.4	104.4	104.4	104.2	103.8	103.6	103.4
7	20	No	Subconjunctiva	100.4	102.7	99.9	99.9	100.1	100.3	100.3	99.9	99.0	98.3
17 lb.		pant-	Vitreous	100.8	104.0	101.6	100.8	100.9	100.9	100.9	100.6	99.9	99.0
(7.7 Kg.)		ing	Orbit	101.3	102.9	101.9	101.2	101.7	101.4	101.1	100.7	100.4	99.8
			Abdomen	102.2	102.5	102.4	102.0	102.0	101.5	101.4	101.6	101.6	101.5

* One electrode was placed 2 inches from the eye and the other 2 inches from the skin at the back of the neck.

† Readings were made within less than one minute (twenty to twenty-one minutes).

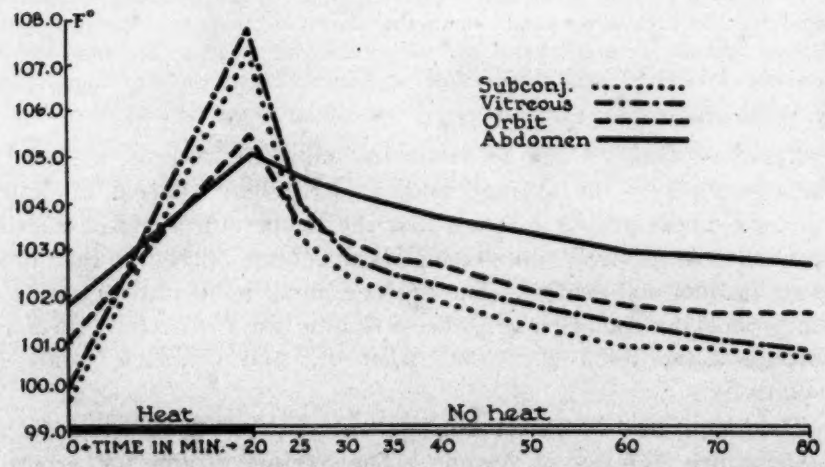

Fig. 1.—Average heating and cooling curves; temperature readings before and after a twenty minute heat treatment. One electrode was placed 2 inches from the eye and the other 2 inches from the skin at the back of the neck.

cates the rapidity with which the heat is disseminated by the vascular system. After eight minutes of cooling, the temperature of both the vitreous (103.2 F.) and the subconjunctiva (102.1 F.) dropped below that of the orbit (103.4 F.). At the end of ten minutes the temperatures of the different structures were still elevated, but the original relations were again approximated; this is clearly shown in figure 1. After sixty minutes of cooling the temperature readings were discontinued, although the thermal level of all the structures was still elevated.

A much greater increase in the temperature of the vitreous was recorded for the 4 animals (table 2) that were irradiated at maximum

TABLE 2.—*Temperature Readings Made Before and After a Ten Minute Heat Treatment* *

Dog No. and Weight	Voltage	Onset of Panting		Temperature Readings: Before Treatment 0′	After Treatment 11′†	15′	20′	25′	30′	35′	40′	50′	70′
8	20	No	Subconjunctiva	95.0	100.4	98.3	95.8						
17 lb.		panting	Vitreous	98.2	103.9	98.8	98.6						
(7.7 Kg.)			Orbit	98.8	101.4	99.2	98.7						
			Abdomen	99.9	101.1	100.9	100.2						
9	20 to	18′	Subconjunctiva	95.8	107.0	102.8	98.4	98.4	98.1	97.9	97.8	97.6	
19 lb.	21.5		Vitreous	96.2	109.3	101.3	100.0	98.6	98.1	97.6	97.4	97.2	
(8.6 Kg.)			Orbit	97.4	101.3	100.0	99.1	98.8	98.6	98.4	98.1	97.6	
			Abdomen	98.8	100.4	100.0	99.7	99.6	99.4	99.0	98.8	98.2	
10	21.5	9′	Subconjunctiva	99.3	106.9	103.3	101.4	101.0	100.5	100.1	99.7	99.4	.
25 lb.			Vitreous	99.4	114.4	104.0	102.2	101.0	100.6	100.2	99.8	99.6	
(11.3 Kg.)			Orbit	99.3	106.4	103.4	102.3	101.3	100.8	100.5	100.2	99.8	
			Abdomen	101.3	104.6	103.7	103.0	102.5	102.0	101.5	101.0	101.0	
11	21.5	9′	Subconjunctiva	97.5	106.3	102.5	101.8	102.0	101.5	101.0	100.8	100.4	99 6
17 lb.			Vitreous	97.3	106.0	103.1	102.3	102.0	101.9	101.8	101.3	100.8	100.1
(7.7 Kg.)			Orbit	99.9	104.7	102.0	102.6	102.5	102.5	102.4	102.1	101.4	100.4
			Abdomen	100.6	106.0	104.0	103.5	103.4	103.3	103.1	102.9	102.6	101.7

* One electrode was placed 2 inches from the eye and the other 2 inches from the skin at the back of the neck.

† Readings made within less than one minute (ten to eleven minutes).

voltage for ten minutes. Figure 2 shows the following average temperature levels at the end of the heating period: subconjunctiva, 106.6 F.; vitreous, 109 F.; orbit, 104 F., and abdomen, 103.6 F. This is to be expected, as the vitreous has a poor blood supply and its heat dissemination occurs chiefly by conduction. At the end of ten minutes of cooling the temperatures were reduced to: subconjunctiva, 100.4 F.; vitreous, 101.2 F.; orbit, 101.4 F., and abdomen, 102.1 F.

Table 3 shows the heating which occurred when the electrodes were placed on each side of the eye. Only 3 dogs are included in this group because our preliminary work convinced us that the response is much less uniform when this technic is adopted.

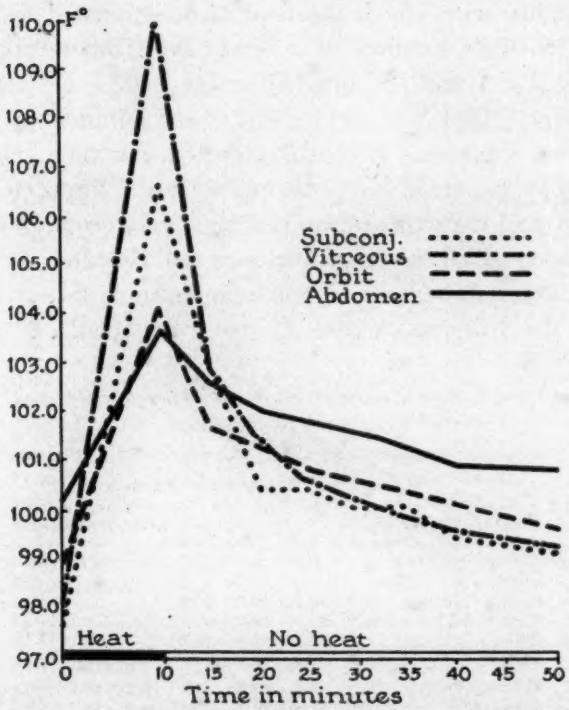

Fig. 2.—Average heating and cooling curves; temperature readings made before and after a ten minute heat treatment at maximum voltage. One electrode was placed 2 inches from the eye and the other 2 inches from the skin at the back of the neck.

TABLE 3.—*Temperature Readings Made Before and After a Twenty Minute Heat Treatment* *

Dog No. and Weight	Voltage	Onset of Panting		Temperature Readings: Before Treatment 0′	After Treatment 21′†	25′	30′	35′	40′	50′	60′	80′
12	20	No	Subconjunctiva	92.4	101.8	97.7	96.2					
18 lb.		panting	Vitreous	94.3	100.8	96.9	95.5					
(5.4 Kg.)			Orbit	94.8	98.3	96.7	96.5					
			Abdomen	95.6	97.7	97.2	97.0					
13	20	18′	Subconjunctiva	97.9	104.8	101.7	100.5	101.0	100.6	100.7	100.1	99.8
24 lb.			Vitreous	99.4	106.7	102.5	101.8	101.4	101.3	101.3	100.8	100.5
(10.9 Kg.)			Orbit	100.5	104.7	103.2	102.7	102.7	102.4	101.9	101.1	100.8
			Abdomen	101.9	103.4	103.4	103.1	103.0	102.8	102.6	102.0	101.7
14	20	No	Subconjunctiva	100.0	103.2	98.9	98.9					
22 lb.		panting	Vitreous	99.6	103.2	100.3	99.6					
(12.7 Kg.)			Orbit	99.8	101.1	100.0	100.0					
			Abdomen	100.4	101.1	100.8	100.4					

* One electrode was placed on each side of the eye, 2 inches from the skin, with an electrode to electrode distance of 5 inches.

† Readings were made within less than one minute (twenty to twenty-one minutes).

TABLE 4.—*Results with a Series of Animals Whose Eyes Were Saved for Section and Microscopic Study*

Dog No. and Weight	Voltage	Panting Time	Temperature Before Treatment, F.	Temperature After Treatment, F.	Comment	Microscopic Changes
15 24 lb. (10.9 Kg.)	22	18′	Abdomen 99.2	Abdomen 103.9	Right ear and back of neck burned; eye enucleated on 7th day and dog killed	Swelling and edema of ciliary nerves; distended perivascular spaces and edema of media in the iris vessels; edema of the delicate iris structure with many polymorphonuclears in the veins; phagocytes in the retina filled with pigment; some retinal degeneration and edema of the internal limiting membrane
16 26 lb. (11.8 Kg.)	19-20	18′	No reading made	.....	Severe burn developed on the skin of the lids on 4th day; eye enucleated on 7th day	Edema of the delicate iris structure with marked engorgement of the iris vessels and perivascular spaces with a great increase in polymorphonuclears; some swelling of the ciliary nerves; some swelling of the optic nerve head; separation of the rods and cones with albuminous infiltrate; glial proliferation of the ciliary nerves
7 20 lb. (9.1 Kg.)	20	18′	Abdomen 102.2	Abdomen 105.6	Eye enucleated on 10th day; no complications	Some swelling of the scleral nerves but much less proliferation than dog 16; some loss in structure in the rods and cones at several points; edema of the internal limiting membrane of the retina
18 23 lb. (10.4 Kg.)	20	12′	Abdomen 102.2	Abdomen 105.4	Eye enucleated on 10th day	Slight swelling of the ciliary nerves; iris vessels engorged with red cells, polymorphonuclears and pigment; retinal degeneration of recent origin; bacilli in many iris vessels and hemorrhage into surrounding tissues; angles of anterior chamber filled with albumin; endothelium of the central portion of the cornea absent, with swelling and necrosis of the stroma; optic nerve head swollen, with some degeneration of the retina; edema of the internal limiting membrane
19 20 lb. (9.1 Kg.)	20	12′	Abdomen 101.4	Abdomen 106.1	No complications; animal killed on 10th day and eye enucleated	Normal except for some edema of the internal limiting membrane
20 18 lb. (8.2 Kg.)	20	No panting	Abdomen 100.3	Abdomen 105.1	Tip of ear burned during treatment; dog died on 13th day and eye enucleated	Some edema of the ciliary nerves in iris; slight separation of the internal limiting membrane; slight posterior subcapsular swelling of the lens
21 21 lb. (9.5 Kg.)	20	No panting	Abdomen 100.3	Abdomen 104.1	No complications; dog killed on 10th day and eye enucleated	Slight swelling of the central part of the corneal stroma; some swelling of the nerves of the iris; posterior subcapsular swelling of the lens; separation of the internal limiting membrane

Table 4 contains the data concerning the series of animals whose eyes were saved for sections and microscopic study. The greatest pathologic changes were observed in dogs 15 and 16. Both of these animals received cutaneous burns, and during the period prior to the removal of their eyes their conjunctivas were injected and the corneas were somewhat cloudy. Dog 16 gave evidence of considerable reaction, but it is difficult to evaluate this because of the presence of micro-organisms; these, of course, could be secondary invaders. There was some swelling of the scleral and ciliary nerves together with a slight separation of the internal limiting membrane (fig. 3) of the retina in the rest of the dogs. Edema of the corneal stroma was observed in only 1 dog (no. 21). This portion of the cornea corresponded to the area least protected during the heat treatment.

Fig. 3.—*A*, engorgement of the vessels of the iris with polymorphonuclear leukocytes (dog 15). The maximum abdominal temperature was 103.9 F. The estimated maximum temperatures from the average heating curve were: subconjunctiva, 106.3 F.; vitreous, 107 F., and orbit, 104.5 F. *B*, separation of the internal limiting membrane of the retina (dog 21). The maximum abdominal temperature was 104.1 F. Estimated temperatures from the average heating curve were: subconjunctiva, 106.7 F.; vitreous, 107.5 F., and orbit, 104.8 F.

Photographic Work.—The Peerless 6 meter short wave apparatus was used in all of the heat experiments in which the retinal vessels were photographed before and after the administration of heat. The air gap electrodes were placed 2 inches from the surface of the body with one 5 inch electrode over the abdomen and the other, a 2 inch one, over one eye.

The photographic technic was the same as that originally described by Lambert[21] and discussed by one of us[22] in a recent publication.

21. Lambert, R. K.: Method for Study of Retinal Circulation, Arch. Ophth. **12**:868 (Dec.) 1934; Am. J. Ophth. **18**:1003, 1935.

22. Puntenney, I.: The Effect of Certain Chemical Stimuli on the Caliber of the Retinal Blood Vessels, Arch. Ophth. **21**:581 (April) 1939.

Control exposures were made at the beginning of each heat experiment, and additional records were made at the end of each treatment. Since excessive respiratory movements interfered with photography, the intensity of the current (transformer setting 2-4) was limited to the point

Fig. 4.—Typical photographs showing the effect of heat on the caliber of the retinal blood vessels. *A*, before, and *B*, after heat treatment.

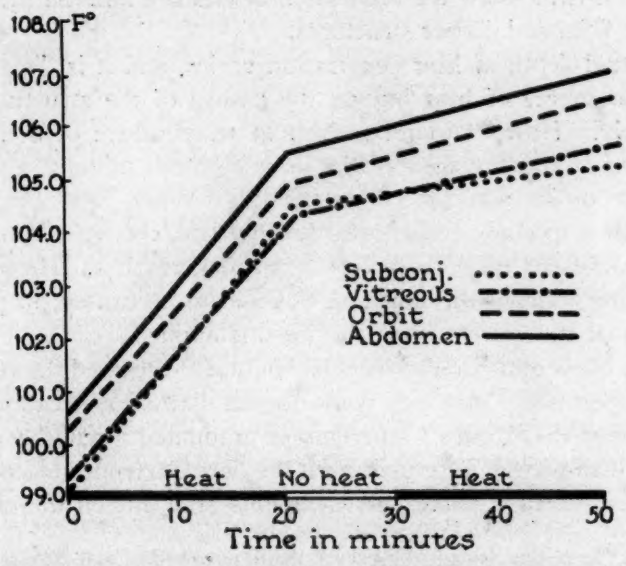

Fig. 5.—Average heating curves. One 5 inch electrode was placed over the abdomen and the other, a 2 inch one, over the eye. The loss of heat during the ten minute cooling period was not recorded.

where the animal would just start to pant toward the end of the first twenty minute heat treatment.

The fundi of 9 dogs were photographed. Neither vasoconstriction nor vasodilatation occurred (fig. 4), so no protocol is given. Control heat-

ing curves were made for a group of 4 dogs which received approximately the same amount of heat as the photographed group. The average graph (fig. 5) is especially interesting when compared with the other graphs (figs. 1 and 2). It shows that the increase in temperature of all the structures (subconjunctiva, 105.1 F.; vitreous, 105.6 F.; orbit, 106.4 F., and abdomen, 107 F.) was fairly constant when one small electrode was placed over the eye and the larger one over the abdomen. The body temperatures of this group were a much more accurate index of the temperature of the vitreous than those of animals heated by either one of the other two methods.

COMMENT

It is generally conceded that the peripheral vessels dilate, either directly or by reflex stimulation, after the administration of heat. This physiologic phenomenon has been shown by Lewis [23] to be part of the local protective mechanism of the body, as burns occur when the vessels are not able to dilate or dissipate the heat fast enough. This type of vasodilatation is desirable in many diseases when elevated temperatures are maintained within physiologic limits. Under such conditions the metabolism of the body is speeded up and enzyme action stimulated. These reactions facilitate the absorption of exudate and aid the nutrition of the superficial and deeper structures.

The actual depth of heat penetration varies, and it is dependent not only on the source of heat but on the nature of the structure and its blood supply. Howe [24] found a drop in temperature of 3 degrees C. (5.4 degrees F.) at the apex of the orbit eighteen minutes after a 3 by 4 cm. piece of ice was placed on the lids. When heat (54 C.) was applied with a specially constructed heating pad, the temperature of the apex was increased only 1 degree C. (1.8 degrees F.). He considered the difference between the heat and the cold to be caused, in part, by a contraction of the vessels when the ice was applied.

In 1932 Moncreiff, Coulter and Holmquest [25] reported the results of a series of experiments in which conventional diathermy treatments were given to anesthetized dogs. Currents of graduated strengths (150, 300 and 600 milliamperes) were used with the bare electrodes placed directly on the lids. Average maximum elevations after fifteen minutes were:

23. Lewis, T.: The Blood Vessels of the Human Skin and Their Responses, London, Shaw & Sons, Ltd., 1927.

24. Howe, L.: On the Coefficient of Thermal Conductivity of Eye and Orbit Measured with Cold Applications, Tr. Sect. Ophth., A. M. A., 1920, p. 134; Coefficient of Thermal Conductivity of Eye and Orbit Measured with Warm Applications, J. A. M. A. **79**:936 (Sept. 16) 1922.

25. Moncreiff, W. F.; Coulter, J. S., and Holmquest, H. J.: Am. J. Ophth. **15**:194, 1933.

orbit, 4.49 degrees C. (8.08 degrees F.); vitreous, 6.98 degrees C. (12.5 degrees F.); anterior chamber, 6.54 degrees C. (11.8 degrees F.), and conjunctiva, 7.11 degrees C. (12.8 degrees F.). All of the dogs were killed at the end of the experiments, and no attempt was made to correlate the temperatures with the late effects.

In our experiments we attempted to correlate heat generation with its dissemination by resolving the data into heating and cooling curves. The abdominal temperatures (figs. 1 and 2) clearly show the speed with which the heat is distributed throughout the body. This relation appears to be fairly constant, and the average graphs are of value in roughly estimating the orbital temperature when only the abdominal temperature is known.

Burns which occur following short wave diathermy are often more severe than burns from a heated body, because the heating occurs not only on the surface but in the deeper structures as well. Cutaneous burns occur more frequently because the greatest current density is present at the electrodes, and this results in an uneven electrical field. It is well to note that special attention must be given to the protection of pointed parts. The concentration of energy in such tissues, which Kling [26] called the "acro effect," accounts for the burning of the ears of animals and heat sensations about the nose and ears in man.

In our experiments burns developed not only in the dogs that had a high elevation in temperature but in some of the animals that gave evidence of only a moderate amount of heating. This discrepancy was no doubt due to the following factors: (1) the anesthetic, which renders the dog incapable of responding to an overdose of energy; (2) the hairy surface of the dog's skin, which alters the electrical field, and (3) the inability of the dog to perspire.

The last is important as it is a factor in determining skin tolerance, which in man is the only safe guide to dosage. It is obvious that it is impossible to determine this in animals.

It is difficult to localize the heating energy to the eye. When the electrodes are placed on each side of the eye, the response is not uniform, and the great concentration of energy in such a small area often produces burns. In order to reduce this danger to a minimum, it is necessary to place the indifferent electrode a greater distance from the eye. This spacing of the electrodes increases the area that is heated, and the rest of the body suffers a much greater increase in temperature. No doubt the safest method is the one in which the second electrode is placed over the abdomen or the thorax (fig. 5). This procedure will not localize the heating to the eye, but it may prove to be the one of greatest therapeutic value.

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26. Kling, D. H.: Burns, Produced by Radio Short Wave and Ultra-Short Wave Therapy and Their Prevention, J. A. M. A. **104**:1981 (June 1) 1935.

The most frequent microscopic changes in the sectioned eye were a slight swelling of the scleral and ciliary nerves and a separation of the internal limiting membrane of the retina (fig. 3). These reactions were of reparable nature, but when too much heat was applied glial proliferation occurred. The injury to the cornea usually corresponded to the area least protected by the lids. In its mildest form, this reaction consisted of edema and cloudy swelling, and in one animal actual necrosis occurred. When the iris was involved, its delicate structure became swollen, and the vessels showed an engorgement with red cells, large mononuclears and polymorphonuclears (fig. 4). In 2 dogs there was a slight posterior subcapsular swelling of the lens, but this did not appear great enough to be comparable to the "thermal cataract" of Hoffmann and Kunz.

The temperature at which these various microscopic changes occurred seemed to vary. In dog 19 there was only slight edema of the internal limiting membrane. The abdominal temperature of this animal changed from 101.4 to 106.1 F. (an increase of 4.7 degrees F.). This value in terms of the average graph is comparable to approximately 109 F., 108.4 F. and 106.6 F. in the subconjunctiva, vitreous and orbit, respectively. In dog 15 there was a much greater amount of reaction with actual retinal degeneration. The abdominal temperature of this dog also increased 4.7 degrees F. (99.2 to 103.9 F.). These individual variations illustrate the difficulty in correlating heat tolerance with heat dosage.

The photographic evidence presented in this work apparently proves that the retinal vessels of the anesthetized dog are not dilated by short wave diathermy. However, the true nature of these reactions may be completely overshadowed by the effect of the pentobarbital sodium, because dilatation may have occurred shortly after the administration of the anesthetic.

PRACTICAL APPLICATION

It is difficult for ophthalmologists to evaluate the response to short wave diathermy. This is especially true when the treatments are given in a routine mechanical manner with no definite proof that heating has taken place. An accurate analysis of this problem necessitates a better understanding of dissemination of heat and of correlation between the temperature of the ocular structures and that of the body.

Our temperatures and dosages are not directly applicable to man, but the uniformity of the heating and cooling curves in our experiments leads us to believe that the body temperature does bear a definite relation to the ocular structures during irradiation. This relation in animals indicates the value of making similar curves in man from which ocular temperature may be estimated when only rectal temperature is known.

We have started such a study in patients with blind eyes that are to be enucleated. Thermocouple readings have been made on 3 patients whose eyes were enucleated shortly after the last heat reading. This work is incomplete, and no comprehensive discussion can be presented at this time. However, in our opinion, clinicians who do not recognize this relation and who fail to include the rectal temperature in their statistics neglect the first step in the approach to this problem.

SUMMARY

An experimental study was made on the heating of the conjunctiva, vitreous and orbit by short wave diathermy.

Temperature readings were made on the ocular tissues during the period of cooling, and these readings were combined with those obtained in the first part of the study to make average heating and cooling curves.

The average heating and cooling curves show that the body temperature bears a definite relation to the temperature of the ocular tissues during heating and cooling. These curves are of value in estimating the ocular temperature when only the rectal or the abdominal temperature is known.

It has been shown that it is difficult to localize the heating energy to the eye.

Microscopic studies have been made to determine the pathologic changes which occur following the administration of short wave diathermy.

New photographic evidence has been presented to show that the caliber of the retinal vessels in the anesthetized dog is not altered by short wave diathermy.

The need for heating and cooling curve studies in man has been pointed out.

The microscopic sections were examined with painstaking care by Dr. Beulah Cushman.

INSTRUMENTS AND TECHNICS FOR THE CLINICAL TESTING OF LIGHT SENSE

II. CONTROL OF FIXATION IN THE DARK-ADAPTED EYE

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It has been known for many years that the region of highest sensitivity in the dark-adapted eye is not at the fovea. This fact was mentioned by Arago [1] in 1858, who pointed out that faint lights could be better seen with eccentric than with foveal fixation. The experiments of Breuer and Pertz, reported in 1897 by von Kries,[2] showed that the relative insensitivity of the fovea in dark adaptation was far more marked than previous studies had indicated, probably because of inadequate control of fixation in these investigations. Breuer and Pertz made quantitative measurements of sensitivity in central and paracentral regions of the retina with white, blue, yellow and red light. The defect in sensitivity at the fovea was most apparent with blue light, less so with white light and least with yellow light. The sensitivity for red light, however, was slightly *greater* at the fovea than in the paracentral retina. Simon in 1904 [3] recognized that the relative insensitivity of the fovea in dark adaptation interferes with the normal tendency toward central fixation. He showed that there was a change in the fixation area of the retina with progressive dark adaptation. He expressed the belief that the direction of eccentric fixation was influenced by the type of muscle imbalance of the subject and also might vary in the same person with change in the size or brightness of the stimulus. The difficulty of controlling fixation in the dark-adapted eye and the possible

This work was supported by a grant from the John and Mary Markle Foundation.

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Arago, F., cited by Parsons, J. H.: An Introduction to the Study of Colour Vision, London, Cambridge University Press, 1924, p. 54.

2. von Kries, J.: Ueber die absolute Empfindlichkeit der verschiedenen Netzhautteile im dunkeladaptierten Auge (Nach Versuchen der Herren Dr. Breuer und A. Pertz), Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. **15**:327-351, 1897.

3. Simon, R.: Ueber Fixation im Dämmerungssehen, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. **36**:186-193, 1904.

sources of error introduced as a result of eccentric and variable fixation have, however, been ignored in many of the instruments and technics devised in recent years for the study of dark adaptation.[4]

The present report is an investigation of several different methods of fixation control to determine which ones are adequate for use in tests of the dark-adapted eye. In examining the different methods the location of the Mariotte blindspot was used as an indicator of the direction of fixation. A number of spots of luminous paint were placed so that they fell just at the edges of the blindspot, determined in light adaptation for a given direction of fixation. If the direction of fixation changes, one of the luminous spots will become visible to the subject. If the spots are accurately located at the borders of the blindspot, it is possible for a good observer to detect an angular change in fixation of about 1 degree. It should be emphasized that, while the blindspot indicator provides an accurate means of *detecting* any deviation in fixation, it does not always succeed in *maintaining* steady fixation. It can be used

Fig. 1.—Luminous fixation device.

in experimental investigations by cooperative intelligent subjects who can be depended on to report the occasional shifts in fixation which occur during a series of observations. It is, however, unsuitable for clinical studies of a large group of persons, because of the cooperation required of the subject. Moreover, because of individual differences in the location and extent of the Mariotte blindspot it would be necessary to map the blindspot and locate the luminous spots at its borders for each subject.

Two other methods of fixation control, suitable for clinical studies, were therefore tested to determine whether or not they could be used to maintain steady foveal fixation in the dark-adapted eye. The first of these is a modification of the luminous fixation target which is one of the accessories of the Ferree-Rand perimeter. A photograph of this device is shown in figure 1. The neutral filter used to reduce the brightness of the fixation target was removed and replaced by a red filter.

4. Sloan, L. L.: Instruments and Technics for the Clinical Testing of Light Sense: I. Review of Recent Literature, Arch. Ophth. **21**:913 (June) 1939.

A rheostat was connected in series with the lamp so that the brightness of the target could be regulated. Because of the detail, a fairly high acuity is required to see it clearly. This and the use of red light probably aid in maintaining foveal fixation. A test of this fixation apparatus, the blindspot device being used to indicate any deviation in fixation, showed that with it steady central fixation was maintained in the dark-adapted eye.

This type of fixation target cannot, however, be used in making tests of the light sense at the fovea, unless the red fixation target is superimposed on the test field itself. Such a procedure is undesirable because the light from the fixation device may have an effect on the determinations. A "perifoveal" fixation target composed of four spots of luminous paint was therefore tried. The angular distance between the upper and the lower spots and between the right and the left spots was 6 degrees. The subject was told to direct his fixation to the center of the region bounded by the four spots. This type of fixation target was found to maintain foveal fixation fairly well. Of the 7 subjects tested, 1 showed somewhat unsteady fixation at all times, and the others showed occasional shifts in fixation. In order to avoid errors in measurement due to such shifts in fixation when the perifoveal target is used, a number of separate determinations should be made. If this is done, the occasional readings in which fixation was incorrect can be detected.

In many of the recently reported studies of light sense in scotopic vision, fixation was controlled merely by instructing the patient to look at the center of the test field.[4] In the earlier articles by Derby and his co-workers [5] it was assumed that by this procedure the light sense of the macular region was tested. In a later report,[6] however, inaccurate control of fixation was mentioned as one of the causes of variability in the results. Delaney [7] stated that his more intelligent subjects avoided the central darkness scotoma by taking an eccentric fixation but that uncooperative patients frequently showed high thresholds because they used foveal fixation. Ferree, Rand and Stoll [8] expressed the belief that with the size of test field used in their instrument there was no incentive to take an eccentric fixation. The test field was a horizontal oblong 10 degrees in width and 3 degrees in height.

5. Waite, J. H.; Derby, G. S., and Kirk, E. B.: The Light Sense in Early Glaucoma, Particularly the Achromatic Scotopic Threshold at the Macula (A Preliminary Report), Tr. Ophth. Soc. U. Kingdom **45**:301-331, 1925.

6. Casten, V., and Shaad, D. J.: Diagnostic Value of Tests of the Light Sense in Early Glaucoma, Arch. Ophth. **9**:52-55 (Jan.) 1933.

7. Delaney, J. H.: Light Sense as Tested by Photometric Glasses of Tscherning, Am. J. Ophth. **13**:1058-1063, 1930.

8. Ferree, C. E.; Rand, G., and Stoll, M. R.: Critical Values for the Light Minimum and for the Amount and Rapidity of Dark Adaptation, Brit. J. Ophth. **18**:673-681, 1934.

In order to test this assumption experimentally, comparative determinations of the adaptation curves with and without an auxiliary fixation control were made. The size of the test field was the same as that used in the Ferree-Rand instrument. No attempt was made to duplicate the brightness of the preexposure field, the size of the pupil or the means of varying the brightness of the test spot, since the purpose of the study was merely to determine whether or not central fixation was maintained when a test field of this size was used. The luminous red foveal fixation device was used in determining the adaptation curves at 15 and 30 degrees from the fovea in the nasal meridian. In determining the

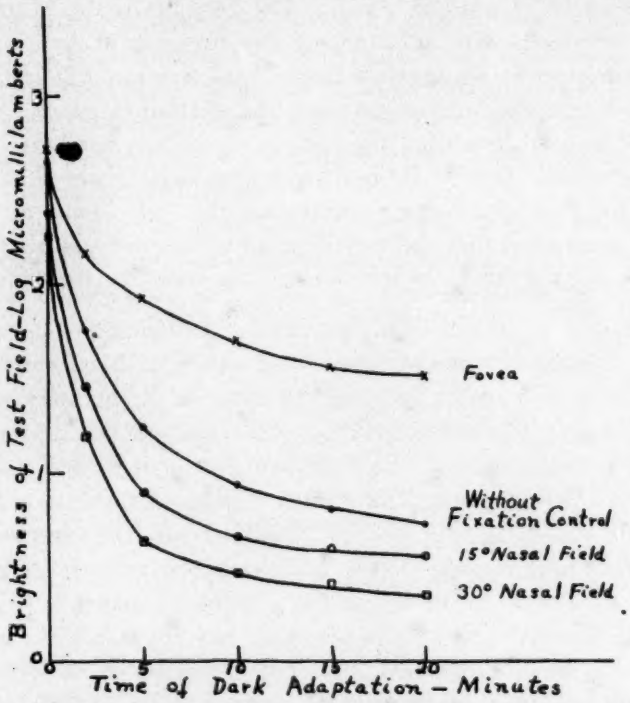

Fig. 2.—Adaptation curves determined with and without auxiliary fixation control.

adaptation curve of the central portion of the retina, a blindspot fixation control was used instead of a perifoveal fixation target because of the large test field. For comparison with these three curves, a fourth series of determinations were made in which the subject was instructed to fixate the center of the test field, but no auxiliary fixation device was used.

Each of the four curves shown in figure 2 represent the average data of three or more separate determinations. An inspection of the chart shows clearly that the curve obtained with uncontrolled fixation

agrees more closely with those for the two peripheral regions than with the curve for the central portion of the retina. The results indicate that some auxiliary fixation control is needed in studying the light sense in scotopic vision. Without such control of fixation, little is known about the region of the retina whose sensitivity is measured except that it is probably *not* the macular region.

SUMMARY

Because of the physiologic central scotoma of the dark-adapted eye, it is not possible to assume that the normal tendency toward foveal fixation is active in scotopic vision. The location of the Mariotte blind-spot may be used as an indication of the direction of fixation. By the use of this device it was shown that foveal fixation was maintained in the dark-adapted eye with a luminous red fixation target. This fixation device can be used in testing the light sense of any region of the retina except the fovea itself. A perifoveal fixation target was described which was found satisfactory for testing the light sense at the fovea. It was demonstrated that the technic used by Ferree and his co-workers and by Derby and his co-workers does not measure the light sense of the central portion of the retina.

INSTRUMENTS AND TECHNICS FOR THE CLINICAL TESTING OF LIGHT SENSE

III. AN APPARATUS FOR STUDYING REGIONAL DIFFERENCES IN LIGHT SENSE

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The instrument described in this paper was devised for the especial purpose of making comparative studies of light sensitivity from the center to the periphery throughout the entire retina. A review of the recent literature on instruments and technics for measuring light sense and dark adaptation [1] indicated that none of them were suitable for this particular type of investigation.

In the first paper of this series I outlined what I believed to be the requirements of an ideal clinical instrument for testing light sense. These requirements were as follows: (*a*) a preexposure field of constant brightness; (*b*) illumination of the test field with light of known composition, variable in intensity by known amounts over a wide range; (*c*) standardization of the size of the pupil; (*d*) control of fixation, and (*e*) norms for distinguishing between pathologic and normal light thresholds. This instrument was devised to fulfil these five requirements and in addition to provide means for testing the light minimum in any desired region of the retina.

Illustrative results are presented for 1 normal subject and for 5 patients with various pathologic conditions of the eye. In these preliminary studies two of the aforementioned requirements have been ignored. 1. The determinations were made without correction for the size of the pupil. This correction is essential for a determination of the threshold in absolute terms but can be omitted in studies the purpose of which is merely to show differences in the threshold in different retinal regions of the same eye. 2. The results for the persons with pathologic conditions of the eye are compared with those for a single normal person. Sufficient data have not yet been accumulated to determine the range of variation of the normal threshold.

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From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Sloan, L. L.: Instruments and Technics for the Clinical Testing of Light Sense: I. Review of Recent Literature, Arch. Ophth. **21**:913 (June) 1939.

DESCRIPTION OF INSTRUMENT

The instrument is designed to be used in conjunction with the Ferree-Rand perimeter. It consists essentially of an attachment which can be mounted at any desired point on the arc of the perimeter. With certain modifications, it could be used with other types of perimeter. The essential features are shown in figures 1 to 3.

1. *Illumination of Test Field.*—In figure 1, *L* is a 3 candle power Mazda no. 64 lamp; *O*, a diffusing plate made from single flashed opal glass and *B*, a Corning no. 590 Daylite glass filter which serves to convert the yellowish light from the bulb to a white light approximating

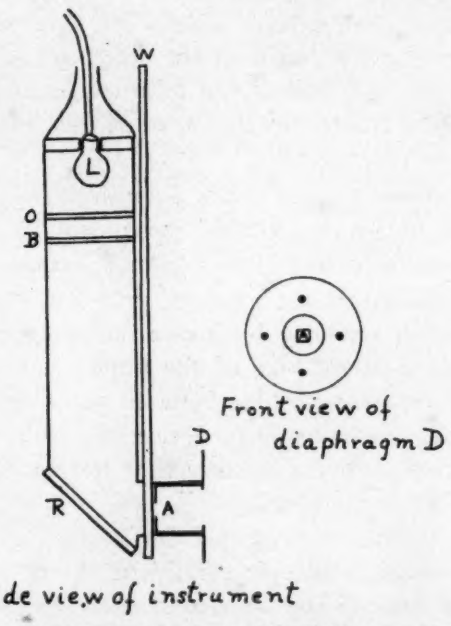

Fig. 1.—Diagrammatic plan of the light sense tester.

daylight in composition.[2] Light from the lamp, *L*, transmitted by the filters, *O* and *B*, illuminates *R*, a white milk glass plate providing a non-selective diffusely reflecting surface. The removable diaphragm, *D*, controls the area of the illuminated test field visible to the patient. The visual angle subtended by the test field depends on the size of the square aperture, *A*. A square rather than a circular test field is used because it is less easily confused with the vague and fleeting sensations of light noticed in the dark-adapted eye as a result of the so-called "intrinsic

2. Means are provided also for inserting color filters in the path of the light beam in order that tests of achromatic sensitivity may be made with light from limited spectral regions as well as with white light.

light of the retina." A 1 degree test field was used in obtaining the data reported in this paper. Other sizes of test field up to 4 degrees may be obtained by using different diaphragms.

The diaphragm *D* also serves two other purposes. (*a*) It prevents light from the perimeter lamp from falling on the test field. Measurements of light sensitivity may therefore be made not only in complete darkness but also under the conditions of illumination which prevail in perimetric examinations. This feature is of value in studying the relation between perimetric and light sense data for a given patient. (*b*) The front surface of the diaphragm carries the fixation device used in

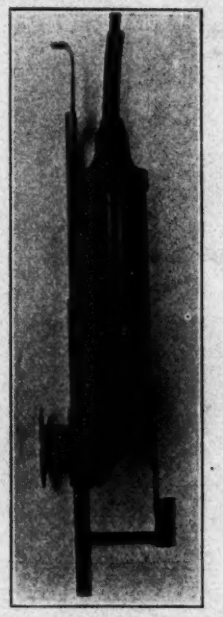

Fig. 2.—Side view of the instrument.

making tests of the light sense at the fovea and close to it. The provisions for control of fixation will later be described in detail.

2. *Means of Varying the Brightness of the Test Field.*—The brightness of the test field is varied by means of a calibrated absorbing wedge, *W*, placed between the diffusely reflecting plate, *R*, and the diaphragm, *D*. This wedge, obtained from the Eastman Kodak Co., uses a colloid pigment to produce the uniform gradation in density. Wedges made with dye mixtures in gelatin become greenish in the course of time and consequently have to be replaced at frequent intervals. The wedge made with colloid pigments, though stable, shows considerable diffusion; consequently the transmission is not entirely independent of the direction of incidence of the light. It is therefore necessary to calibrate

the wedge in place, with the illuminated diffusing plate, *R*, acting as the source of light.[3] The portion of the wedge in front of the illuminated surface is indicated on a graduated scale. As a rule it is necessary to use a short compensating wedge in addition to the movable wedge, in order to obtain a constant density throughout the portion interposed in the beam of light. In this instrument a balancing wedge was found to be unnecessary because the slightly higher brightness of the upper

Fig. 3.—Light sense tester mounted on perimeter arc. F_1 indicates the foveal fixation control, consisting of a luminous red fixation target; F_2 the perifoveal fixation control, consisting of spots of radium paint surrounding the test field.

portion of the white diffusing plate compensated for the greater density of wedge in the upper half of the field and resulted in approximately equal brightness over the area of the test field.

3. In making this calibration, a light source of higher candle power was substituted for the standard lamp, *L*. This was necessary in order to obtain sufficient intensity when the densest portion of the wedge was in front of the illuminated surface, *R*.

The calibration data are shown graphically in figure 4, in which scale readings in centimeters are plotted on the abscissa and the relative brightnesses, in logarithmic units, on the ordinate. In order to avoid negative values of log B, a small unit of brightness is chosen, equal to 1 micromillilambert, or 10^{-6} millilamberts. Zero on the logarithmic scale is thus equal to 1 micromillilambert, 5 on the logarithmic scale to 10^5 micromillilamberts, or 0.1 millilambert, etc. As will be seen from the graph, the scale reading S is proportional to log B. The equation showing the relationship between S and log B is log B = C — S/4, in which S is the scale reading in centimeters, B the brightness of the test spot in micromillilamberts and C the value of log B corresponding to a scale reading of zero. The numerical value of the constant C depends on

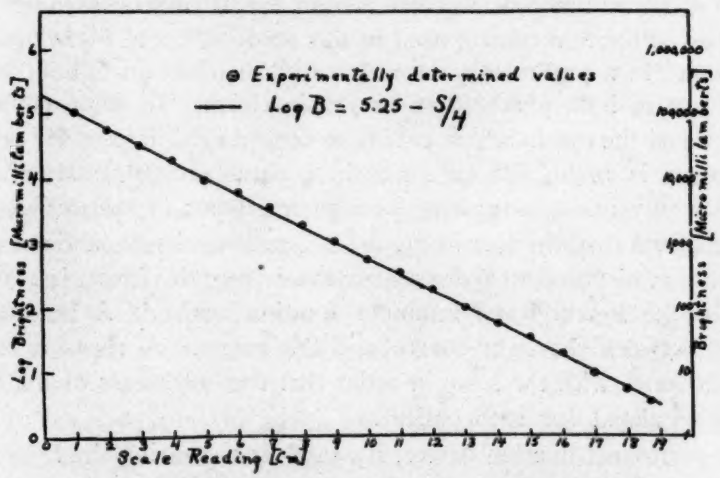

Fig. 4.—Calibration of the curve of the light sense tester.

the candle power of the light source, *L*, and must be redetermined from time to time in order to detect possible changes due to aging of the lamp. Whenever a new lamp is inserted, the value of the constant C must also be redetermined. To obtain the numerical value of C, a measurement is made of the brightness of the test field for any given setting of the wedge and the value of C computed from the equation. For example, assume that when the wedge is at 1 cm. the brightness of the test field is 1,000,000 micromillilamberts (log B = 6). Substitution of these values for log B and S in the equation gives 6 = C — ¼, or C = 5.75. Because of the wide range of brightness to be represented in graphs showing change in light minimum with dark adaptation and in those showing variations in light minimum throughout the retina, it is convenient to express brightness in logarithmic rather than in arithmetic units. Logarithmic units are also of advantage because equal differences

correspond to equal percentage changes in brightness. Since the scale readings of the instrument are proportional to log B, for most purposes the data may be plotted directly in terms of the scale readings in centimeters.

3. *Provisions for Making Tests in Any Desired Region of the Retina.*—In measuring the light sense at a given location in the field of vision, the subject's fixation is directed toward the center of the perimeter arc. The tester is fastened on the arc at the desired distance from the fixation point by means of a small set screw. The arc itself may then be rotated to any meridian. In order that determinations may be made in the dark, some form of luminous fixation object must be used. Because of the physiologic central scotoma which develops with dark adaptation, the device used must be such that the tendency to take an eccentric fixation is overcome and foveal fixation assured. The two types of fixation control used in this study (F_1 and F_2 in figure 3) were found in a preliminary investigation [4] to maintain fixation of the normal eye in both photopic and scotopic vision. In some pathologic conditions of the eye in which extensive central field defects are present, however, it is impossible to maintain accurate foveal fixation. The same difficulty arises in making perimetric studies in such cases.

The foveal fixation device, F_1, used in making determinations of the light sense at distances of 6 degrees or more from the fovea, is a modification of the Ferree-Rand luminous fixation device.[4] A red filter is inserted between the light source and the target. A rheostat is connected in series with the lamp in order that the brightness of the target may be regulated for each patient.

The perifoveal fixation device, F_2, used in measuring the light sense at the fovea, is shown in figures 1 and 3. It consists of four spots of radium paint (S in figure 1) on the front of the diaphragm, above, below, to the right and to the left of the test field, at angular distances of 3 degrees from its center. The subject is instructed to direct his fixation to the center of the area bounded by these four fixation points. This device may also be used in making determinations of the light sense at 3 degrees from the fovea. For example, the light sense at a point 3 degrees above the fovea is measured in the light-adapted eye by instructing the patient to fix the lower spot of luminous paint. In the dark-adapted eye, however, the luminous spot disappears completely when its image falls on the fovea because of the central scotoma. In dark adaptation, therefore, the subject is instructed to turn his eye in the direction in which the spot *disappears*.

4. Sloan, L. L.: Instruments and Technics for the Clinical Testing of Light Sense: II. Control of Fixation in the Dark-Adapted Eye, Arch. Ophth., this issue, p. 228.

4. *Provisions for Controlling the Time of Exposure of the Test Field.*—With previously described instruments, the usual method of determining the light minimum consists in decreasing the brightness of the test field until it becomes invisible and then increasing it again until it is just visible to the subject. It was found in preliminary studies, however, that somewhat more reproducible results are obtained if successive short exposures of the test field are given, while the brightness is gradually decreased or increased by means of the wedge. For this purpose a contact key with a hold-down switch was used. The time of illumination of the test field was kept approximately constant at one second. A more accurate control of time of exposure can be obtained by interposing a camera shutter in the path of the light beam. Comparative tests of the reproducibility of the results when exposures of one second were made with a camera shutter and with a contact key showed, however, no significant gain in reproducibility with the more accurately controlled time of exposure. For this reason it was decided not to complicate the apparatus unnecessarily by the addition of the camera shutter.

5. *Method of Making and Recording Readings in the Dark.*—A small pencil flashlight, with a shield containing a red filter, is used by the operator when tests are made in the dark room. From this flashlight a small spot of dim red light may be directed on the scale of the wedge, the stopwatch or the record sheet. If the patient's eyes are closed while this light is on, it is not perceptible to him and does not influence the determinations of the light sense.

6. *Procedure.*—With the apparatus described, three types of determinations of the light sense may be made.

(*a*) The thresholds may be determined at intervals from the center to the periphery with the perimeter lamp lighted. The level of adaptation then corresponds to that which prevails when perimetric tests are made with the Ferree-Rand instrument. The gray perimeter arm which serves as the adapting field has a brightness of 0.7 millilambert.

(*b*) Similar determinations may be made in the dark, after the eye has reached a more or less steady state of dark adaptation. The difference in thresholds, in logarithmic units, for condition [*a*] and condition [*b*] gives a measure of the increase in sensitivity with dark adaptation at each of the regions of the retina tested.

(*c*) The adaptation curve, showing the rate of increase in sensitivity with dark adaptation, may be determined for any selected region of the retina.

The usual procedure in making a series of tests is as follows: Measurements of the light minimum of the light-adapted eye are first

made throughout one meridian. A curve of dark adaptation for one selected location is next determined. When the readings show no further significant increase in sensitivity with time in the dark, the eye may be considered to have reached a steady state of dark adaptation. Measurements of the threshold in scotopic vision are then made for the same retinal regions that were tested in the light-adapted eye.

ILLUSTRATIVE RESULTS [5]

1. *Results of Light Sense Studies in a Normal Eye.*—The two curves in figure 5 show the thresholds from the center to the periphery in the horizontal meridian for the light-adapted eye and for the dark-adapted eye. In the light-adapted eye the sensitivity is greatest at the fovea and decreases gradually toward the periphery. At about 45

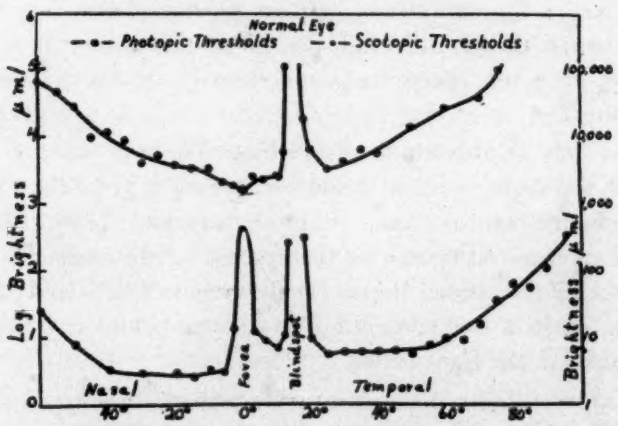

Fig. 5.—Photopic and scotopic thresholds in the horizontal meridian of a normal eye.

degrees in the nasal field and 55 degrees in the temporal field, for example, the light minimum is approximately 1 logarithmic unit greater than that at the fovea, i. e., about 10 times the foveal light minimum. There is a region of low sensitivity at the borders of the blindspot, of somewhat greater extent on the temporal than on the nasal side.

In the dark-adapted eye the sensitivity gradient is essentially the same except at the fovea, where the marked peak in the curve indicates a region of relatively low sensitivity. The foveal threshold is, for example, 100 times as great as that at 6 degrees in the nasal field. From 6 to 40 degrees in the nasal meridian there is no appreciable change; beyond 40 degrees there is a gradual decrease in sensitivity.

5. The measurements were made with the natural pupil. Cases in which abnormalities in the size of the pupil may have been a factor will be discussed in relation to the findings in the individual cases.

In the temporal field the sensitivity is approximately constant from 25 to 50 degrees and decreases gradually beyond 50 degrees. Even in the far periphery, however, the sensitivity is greater than that at the fovea.

The separation of the two curves on the vertical axis gives a measure of the range of adaptation, or decrease in light minimum, which occurs with change from light to dark adaptation. Thus if B_L is the light minimum of the eye when adapted to 0.7 millilambert and B_D that of the dark-adapted eye, then log B_L — log B_D or log (B_L/B_D) may be taken as a measure of the range of adaptation or an increase in sensitivity with dark adaptation. Figure 6 shows graphically the range of adaptation in the horizontal meridian. The range in the periphery is 3 or more logarithmic units and that at the fovea only about 0.5 logarithmic unit, corresponding in arithmetic units to more than a

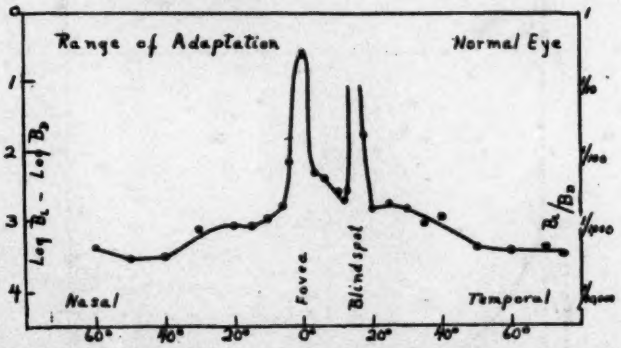

Fig. 6.—Range of adaptation or decrease in thresholds with dark adaptation in the horizontal meridian of the normal eye.

thousandfold increase in sensitivity in the periphery but only about a threefold increase at the fovea.

The relative insensitivity of the foveal region in dark adaptation is illustrated also in the adaptation curves shown in figure 7. In this chart time of adaptation is plotted on the abscissa and the corresponding values of the light minimum are plotted in logarithmic units on the ordinate. This figure shows the adaptation curves for the fovea and for the region 15 degrees from the fovea in the nasal meridian. The beginning and the end points of these curves correspond respectively to the data shown in figure 5, giving the values of the light minimum in light adaptation and in dark adaptation. The intermediate points show the successive values of the light minimum during the process of dark adaptation. It is apparent from the curves that the foveal region reaches its maximum sensitivity after about six minutes of dark adaptation and the paracentral region only after about twenty minutes.

2. Preliminary Studies in Various Pathologic Conditions.—A few preliminary studies have been made on patients with idiopathic flat detachment of the macula, pigmentary degeneration of the retina, primary atrophy of the optic nerve, tryparsamide amblyopia and vitamin A deficiency. These are shown in figures 8 to 20. While the studies of these conditions are far from complete, a few cases are presented to illustrate the various deviations from normal which may be found in different types of pathologic conditions of the eye. In each case data for only one eye are given.

CASE 1.—The patient had an idiopathic flat detachment of the macula, essentially similar to those reported by Walsh and me in 1936.[6] The appearance of

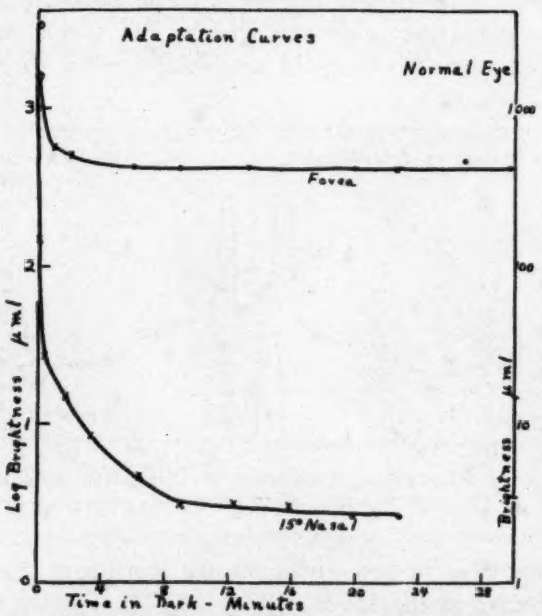

Fig. 7.—Adaptation curves of a normal eye showing rate of decrease in the threshold with dark adaptation, at the fovea and at 15 degrees in the nasal field.

the fundus was typical of this condition. The corrected visual acuity was 20/20 —. The central visual field is shown in figure 8. In the lower temporal meridian between 5 and 10 degrees from the fixation point there was a small paracentral scotoma, absolute for a 1 degree blue test object. The same test object appeared green in a considerably larger area, which included the fixation point.

Determinations of the light minimum in this case were made in an oblique meridian in order to include the region in which there was an absolute scotoma. The thresholds of the light-adapted eye are shown in figure 9, and for comparison the corresponding data for a normal eye. The threshold curve shows, in com-

6. Walsh, F. B., and Sloan, L. L.: Idiopathic Flat Detachment of the Macula, Am. J. Ophth. **19**:195-208, 1936.

parison with that of the normal eye, a localized reduction in light sensitivity corresponding closely with the perimetric findings. The region in which the threshold is increased extends from about 3 degrees in the upper nasal meridian to about 15 degrees in the lower temporal meridian. The most marked defect

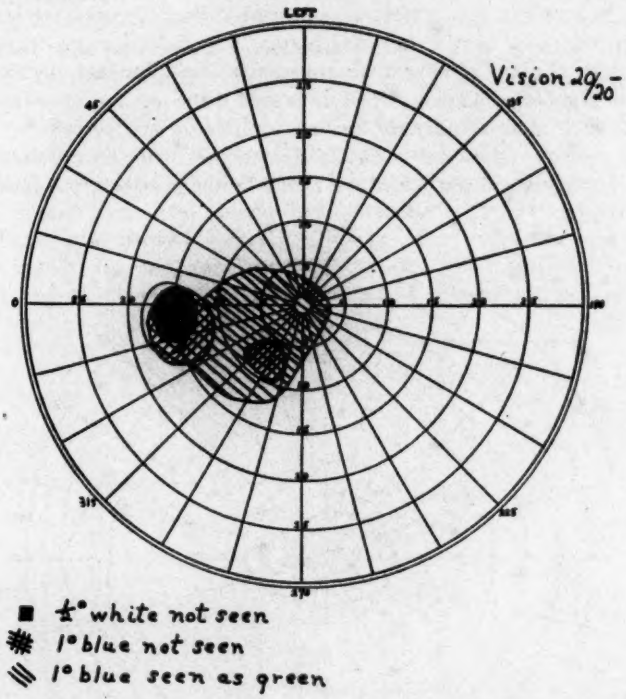

Fig. 8 (case 1).—Central visual field in a case of idiopathic flat detachment of the macula.

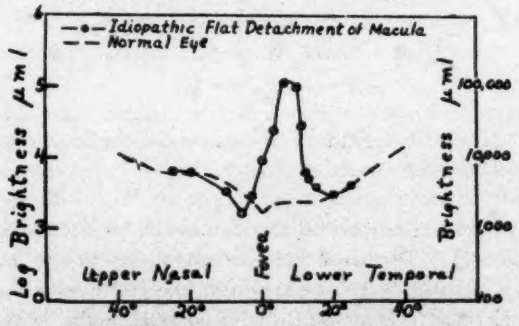

Fig. 9 (case 1).—Photopic thresholds in the upper nasal and the lower temporal meridian in a case of idiopathic flat detachment of the macula.

occurs between 6 and 10 degrees in the lower temporal meridian. In this region the thresholds differ from those of the normal eye by about 1.6 logarithmic units. In arithmetic units this is equivalent to a threshold 40 times that of the normal eye. No determinations were made in this case of the light sense in scotopic vision.

CASE 2.—The second case illustrates a different type of defect in light sense, in which the most marked loss in sensitivity occurs in the periphery. This patient had pigmentary degeneration of the retina and bilateral incipient cataract. Studies of the light sense were made in the right eye only. The corrected visual acuity of the right eye was 20/30. The visual field is shown in figure 10. The field for a 1 degree white test object was limited to a central area, 20 degrees or less in extent, and a crescentric area in the far periphery. The field for ½ degree blue test object was only slightly smaller than the central field for a 1 degree white test object. The perimetric findings thus indicated little or no involvement of the central field, with almost complete loss of function in the periphery. The slight reduction in central vision was probably due to the incipient cataract and not to involvement of the central portion of the retina by the pigmentary degeneration.

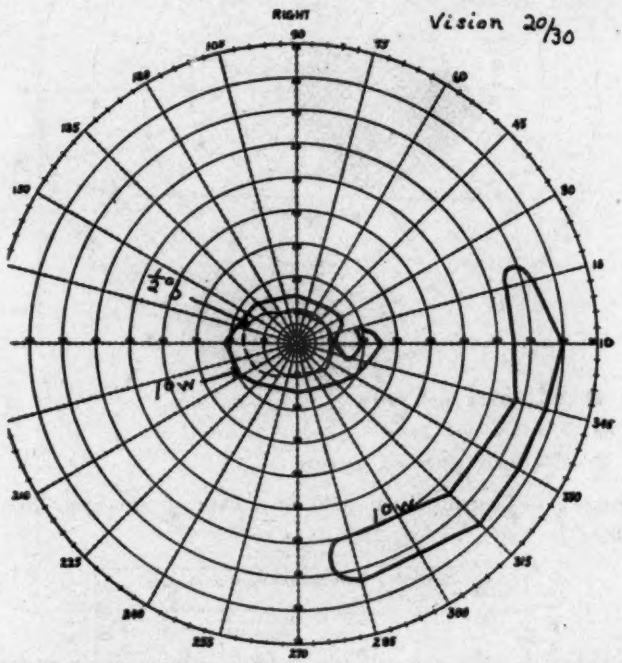

Fig. 10 (case 2).—Visual field in a case of pigmentary degeneration of the retina and incipient cataract.

Threshold curves of the horizontal meridian for both light and dark adaptation are shown in figure 11. The data for photopic vision are in general agreement with the perimetric findings. A comparison of the curve with that of the normal eye shows a normal sensitivity at the fovea, a possible slight decrease in sensitivity in the paracentral regions and abrupt decrease in sensitivity at about 10 degrees from the center. In the far periphery the test spot could not be seen at the highest brightness provided by the instrument.

The light minimum of the dark-adapted eye also shows an abrupt rise in the midperiphery. Determinations could not be made beyond 26 degrees in the nasal field and 28 degrees in the temporal field because the threshold brightness was higher than the maximum provided by the instrument. In scotopic vision the central as well as the peripheral regions showed a marked decrease in sensitivity

when compared with the data for the normal eye. The separation between the curves for light and dark adaptation was much less than in the normal eye at every point tested. The fovea, for example, showed practically no increase in sensitivity with dark adaptation. In this case, therefore, in addition to the decrease in sensitivity to light demonstrable in photopic vision, there was a further defect apparent only when tests were made in dark adaptation. The reduced range of dark adaptation was present throughout the entire region in which measurements were made of the light sense.

CASE 3.—This case illustrates a type of deficiency in light sense in which the light minimum is increased in about the same proportion in light and in dark adaptation, and the range of adaptation, therefore, is of the same magnitude as that of the normal eye. The patient had advanced syphilitic atrophy of both of the optic nerves and Argyll Robertson pupils. The right eye was blind. The corrected vision in the left eye was 20/200 + 1. The visual fields of the left eye for 3, 1 and ½ degree white test objects and 3 degree blue test objects are

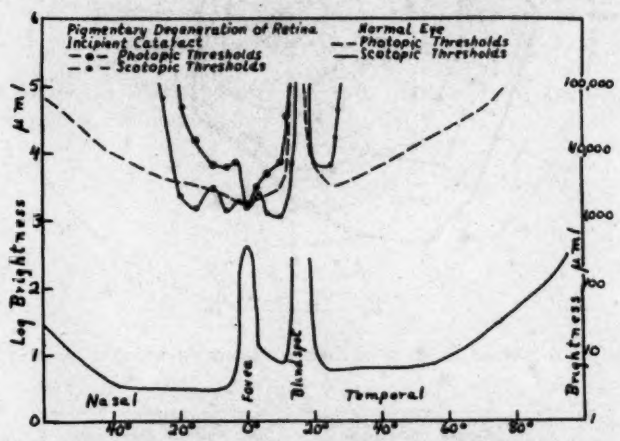

Fig. 11 (case 2).—Photopic and scotopic thresholds in the horizontal meridian in a case of pigmentary degeneration of the retina and incipient cataract.

shown in figure 12. A 3 degree red test object was not seen anywhere in the field of vision. The perimetric studies indicated an involvement of the entire field of vision, with especially marked defects in the nasal field. The light sense data are shown in figure 13.[7] Determinations were made in the horizontal meridian for both photopic and scotopic vision. In light adaptation the light minimum was definitely higher than that of the normal eye in all of the regions tested. Determinations could not be made beyond 27 degrees in the nasal meridian and 35 degrees in the temporal meridian because the thresholds were greater than the maximum available brightness.

7. The left pupil, measured under the conditions prevailing in determining the photopic threshold curve, was approximately 4 mm. in diameter. In the dark, the pupil presumably did not dilate further. Although a light minimum slightly higher than normal might therefore be expected because of the small pupil, the increase in light minimum found was greater than could be accounted for on this basis alone.

In dark adaptation, likewise, the light minimum was definitely greater than normal except for the fovea. (The determinations at the fovea were somewhat variable, probably because the four point fixation device did not maintain an

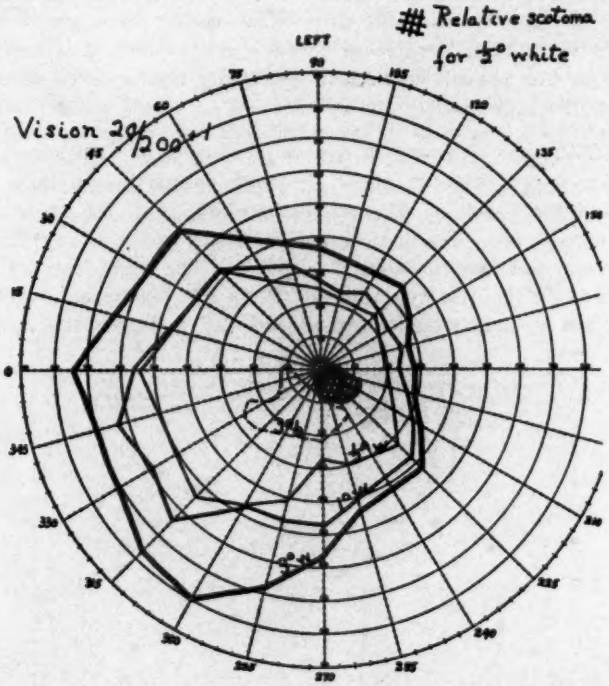

Fig. 12 (case 3).—Visual field in a case of primary atrophy of the optic nerve.

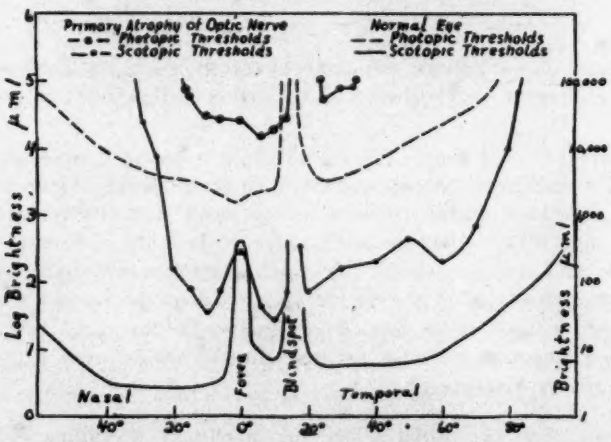

Fig. 13 (case 3).—Photopic and scotopic thresholds in the horizontal meridian in a case of primary atrophy of the optic nerve.

entirely steady fixation in dark adaptation. It is possible, therefore, that the measurement obtained for the foveal threshold actually represents that of the more sensitive paracentral retina.) The steep rise in threshold which occurred

between 20 and 30 degrees in the nasal meridian corresponded to the nasal cut in the visual fields.

Inspection of the two curves in figure 13 shows that they differ from the curves for the normal eye by approximately the same amount. This indicates that the

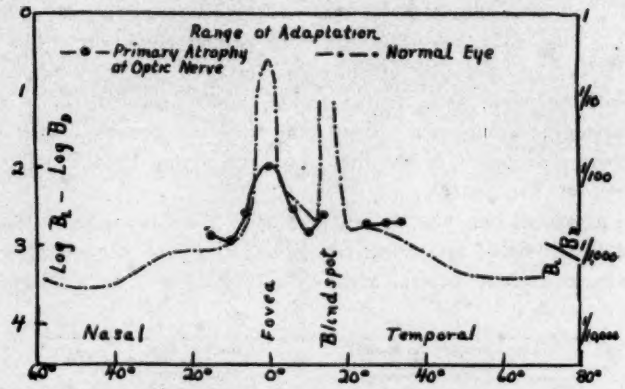

Fig. 14 (case 3).—Range of adaptation in the horizontal meridian in a case of primary atrophy of the optic nerve.

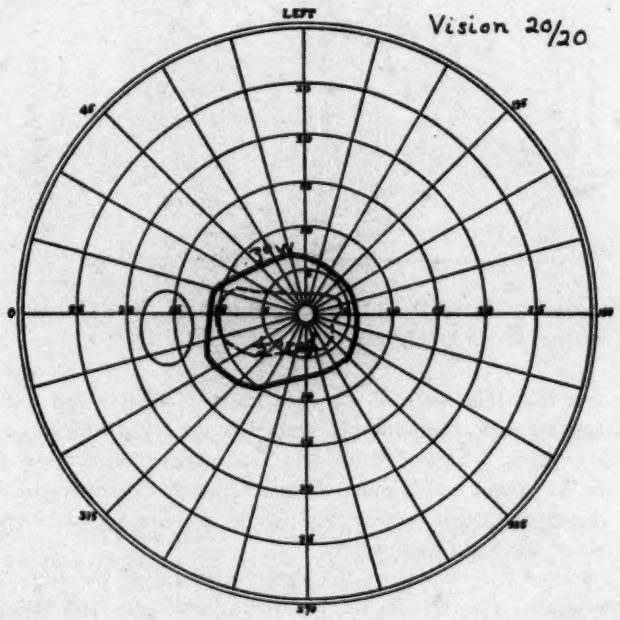

Fig. 15 (case 4).—Visual field in a case of tryparsamide amblyopia.

deficiency in sensitivity to light was of about the same magnitude in the light-adapted and in the dark-adapted eye and that the gain in sensitivity with dark adaptation was of the same magnitude as that of the normal eye. Figure 14, which shows the range of adaptation for this subject and for the normal eye, illustrates this more clearly. It will be noted that the range at the fovea is greater than that of

the normal eye. This finding is due to the fact that the fovea showed a decreased sensitivity in light but not in dark adaptation. As pointed out previously, however, the measurements at the fovea are somewhat open to question because of unsteadiness of fixation.

CASE 4.—This case illustrates defects in light sense somewhat similar to those in case 2 but due to an entirely different ocular condition. The patient had moderately advanced syphilitic atrophy of the optic nerves. Shortly after this was diagnosed he was given tryparsamide, which resulted in a superimposed severe tryparsamide amblyopia. Since that time the defects of the visual fields, vision and degree of pallor of the disks have shown no change. The patient has been followed for five years.

Data are presented here for the left eye only. The corrected visual acuity was 20/20. The visual fields are shown in figure 15. A 3 degree white test object was seen only in a small central area, extending from 6 to 11 degrees from the

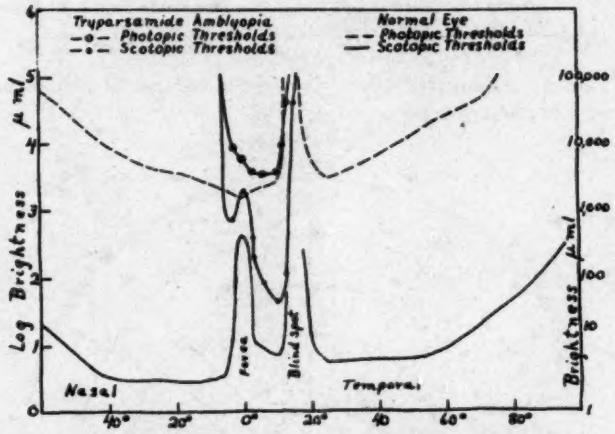

Fig. 16 (case 4).—Photopic and scotopic thresholds in the horizontal meridian in a case of tryparsamide amblyopia.

fovea. The fact that the limits of the field for a ½ degree red test object were only slightly smaller indicates a sharply limited defect with little or no involvement of the central region. This patient also had Argyll Robertson pupils. The diameter of the left pupil was 3 mm. If one assumes a diameter of 6 mm. in the normal eye, the miotic pupil in this case would account for an increase in light minimum of about 0.6 logarithmic units.

Figure 16 shows the results of the determinations of the light sense in the horizontal meridian. The thresholds for both light and dark adaptation were only slightly higher than normal in the central regions but showed a sudden increase at 6 degrees in the nasal field and at 12 degrees in the temporal field. Beyond these limits the thresholds were greater than the maximum brightness of the test spot. The threshold curve of photopic vision resembled that of the patient with pigmentary degeneration of the retina (case 2) in that there was relatively normal sensitivity in the center with a marked defect in the periphery. In this case, however, the central region showed a fairly normal increase in sensitivity

with dark adaptation, whereas in case 2 there was a marked decrease in the range of adaptation.

CASE 5.—The patient had an experimentally produced vitamin A deficiency. Tests were made on Jan. 7, 1938, after he had been on a diet low in vitamin A for forty-two days and again on January 19, after known amounts of vitamin A had been added to the diet.[8] Ophthalmologic examination of the patient on January 7 showed normal fundi and vision of 20/20. Examination with the slit lamp, under high magnification, showed a normal corneal epithelium. The visual fields of the right eye are shown in figure 17. The fields of the left eye were essentially similar. Tests with 3 and ½ degree white test objects showed moderate concentric contraction. The limits for a 1 degree blue test object (not charted) were

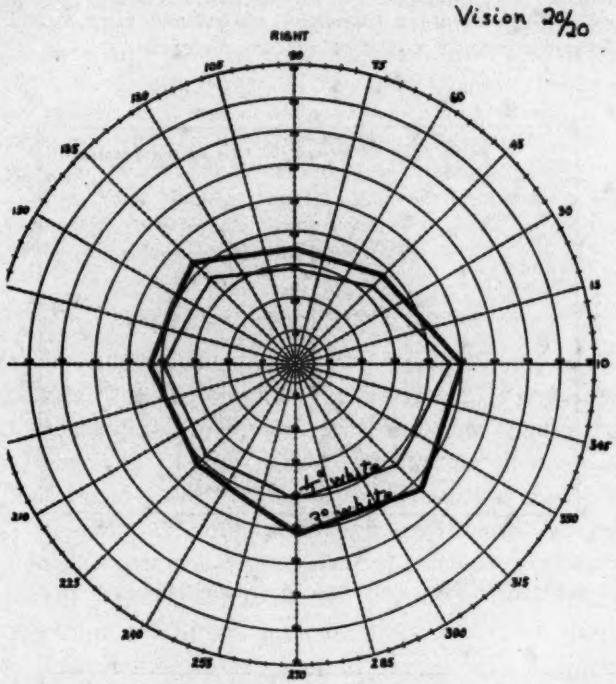

Fig. 17 (case 5).—Visual field before vitamin A therapy in a case of vitamin A deficiency.

of normal extent. Near the limits of the field for a 1 degree blue test object, however, there were small areas in which the test object appeared somewhat dim. The extent of these doubtful scotomatous regions was too indefinite for accurate mapping.

The results of the tests of the light sense made before and after vitamin A therapy are shown in figures 18 and 19. The latter differ only slightly from the

8. Dr. Lela E. Booher gave me permission to examine this subject. This case is also reported as case 1 in the article by Booher, Callison and Hewston (An Experimental Determination of the Minimum Vitamin A Requirements of Normal Adults, J. Nutrition **17**:317-331 [April 10] 1939). Further details as to the dietary regimen, etc., may be obtained from this report.

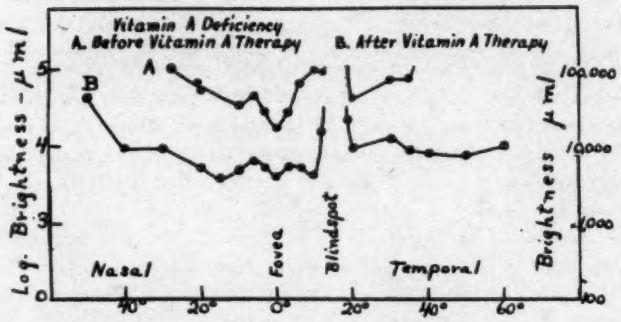

Fig. 18 (case 5).—Photopic thresholds before and after vitamin A therapy in the horizontal meridian in a case of vitamin A deficiency.

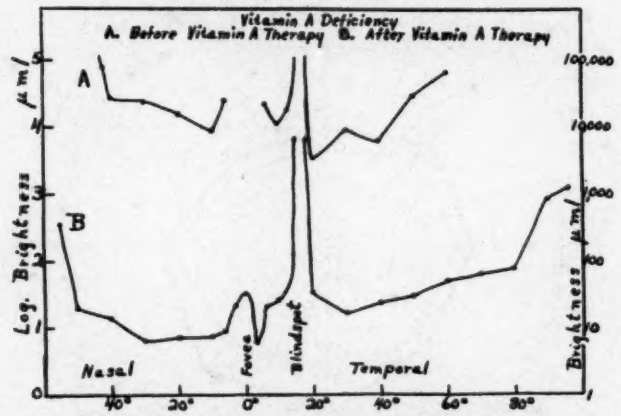

Fig. 19 (case 5).—Scotopic thresholds before and after vitamin A therapy in the horizontal meridian in a case of vitamin A deficiency.

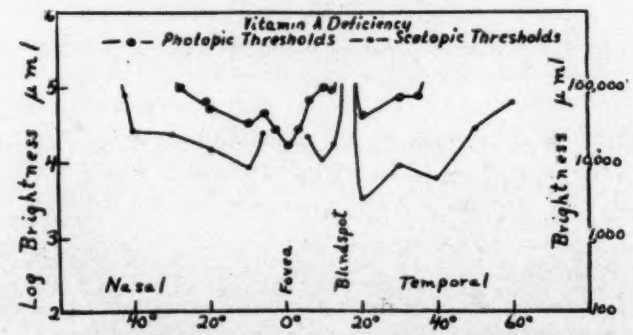

Fig. 20 (case 5).—Photopic and scotopic thresholds in the horizontal meridian before vitamin A therapy in a case of vitamin A deficiency.

findings in a normal eye and probably indicate, therefore, a fairly complete recovery from the ocular effects of the vitamin A deficiency. In figure 18 *A* and *B* are the curves for the light-adapted eye before and after vitamin A therapy. The values of the light minimum in curve *A* are on the average about 1 logarithmic unit higher than in curve *B*, indicating about a tenfold increase in the light minimum.

In dark adaptation the deficient sensitivity to light was far more marked. The data [9] charted in figure 19 show a difference of more than 3 logarithmic units in the values of the light minimum before and after vitamin A therapy. This is equivalent to more than a thousandfold increase in the threshold.

In figure 20 the threshold curves for both light and dark adaptation are shown for comparison on the same chart. The small separation between the two curves indicates a marked decrease in range of adaptation, particularly in the nasal field.

Although in this case the visual defects were demonstrable in moderate light adaptation both by ordinary perimetric tests and by tests of the light minimum, the deviations from normal were far more marked in dark adaptation. It seems probable, therefore, that milder degrees of vitamin A deficiency might be apparent only in scotopic vision. It is not possible to say, from the results in this case, whether in less severe vitamin A deficiency the entire retina is affected simultaneously or whether the deficiency in light sense is localized in certain regions of the retina. If, as these findings suggest, the entire retina is always affected in vitamin A deficiency, then tests of light sense in a single retinal region should be sufficient for the early detection of this condition.

SUMMARY AND CONCLUSIONS

An instrument to test the light minimum in photopic and scotopic vision and the rate of dark adaptation is described. The salient features of this apparatus are fixation devices and a movable stimulus, permitting tests of the fovea and of any desired regions of the paracentral and peripheral portions of the retina. Typical results found in normal persons and in patients with pathologic conditions of the eye are presented.

It is apparent from these preliminary studies that different forms of ocular pathologic conditions may be associated with deficiencies in sensitivity to light which differ qualitatively as well as quantitatively. The defects may be localized or may affect the entire retina; they may or may not affect photopic and scotopic vision equally. It is conceivable also that the light sensitivity could be normal in both light and dark adaptation with abnormalities only in the rate of dark adaptation.

Further detailed studies are needed to determine the types of defect of the light sense characteristic of different forms of ocular pathologic conditions. After such studies have been made for a number of patients, it should be possible to select simpler test procedures, suitable for detecting the different types of defect of the light sense. Previous studies have emphasized chiefly the rate of dark adaptation and have paid little attention to regional differences in sensitivity.

9. The test was unfortunately interrupted before determinations of the foveal light minimum were made.

PARADOXIC ELEVATION OF THE LID

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So far as I can ascertain, the case report which follows will in itself be of no practical value to any one. It is presented, however, because no exactly similar phenomenon has been found in the literature and because it has stimulated certain reflections on the movements of the lids.

REPORT OF A CASE

Beverly L., aged 10 years, was first seen in 1935. At the age of 6 years she had suffered a severe attack of pneumococcic meningitis, after which the left eye had turned out and the upper lid had drooped. Immediately after the illness paralysis of the right leg and arm was present, but this cleared up completely. There were also cerebral changes, resulting in a peculiarly unstable temperament, with extreme restlessness and flight of ideas. The child presented the picture of complete paralysis of the left third nerve, with, in addition, complete paralysis of elevation and depression of both eyes.

It was considered that a supranuclear lesion had caused paralysis of elevation and depression and that this lesion, affecting the movements of both eyes, had been accompanied by damage to the left third nerve or to its nucleus, which further complicated the picture. The paradoxic movement of the lid to be described was not noted at this time.

A Blaskovics operation on the left upper lid produced a slight effect. Strong contraction of the frontal muscle was still necessary to uncover the left pupil, as in *A* of the accompanying illustration. When the patient was seen again after three years the peculiar reaction of the lid was noticed. It had been noticed by the mother for a number of years, but she was not sure whether it had been present before the operation for ptosis. When the right eye was opened naturally, the left upper lid drooped completely. During natural winking movements, each time the right lids were closed the left upper lid showed a spastic movement of elevation. The lid was raised 5 to 6 mm., the movement lasting less than a second, after which complete relaxation of the lid occurred immediately. The movement was evidently made by the levator muscle, since the frontalis muscle did not participate. On natural closure of the eyes, as in sleep, and on forced closure the same rapid elevation of the lid occurred, although it was sometimes slighter than the movement seen in winking (*B* and *C* of illustration). After this rapid movement executed by the levator muscle, the lid was elevated by the frontalis muscle 3 to 4 mm. and remained in this position during forced closure of the right lid. The quick movement was not under voluntary control but occurred automatically with each closure of the right lids. There was no upward movement of either eye on closure of the lids, the left eye remaining turned 15 degrees lower than the right and abducted about 50 degrees. No similar retraction occurred when the child attempted to look up or down. The left pupil was dilated and did not react to light or in accommodation.

From the Department of Ophthalmology, Northwestern University Medical School.

Recession of the left external rectus muscle and transplantation of the left superior oblique muscle to the insertion of the internal rectus muscle improved the position of the left eye to some extent, and a Machek operation resulted in fairly good correction of the ptosis. The paradoxic reaction of the lid was unchanged by this procedure except that the whole cornea was now uncovered during the movement.

REVIEW OF LITERATURE

Thurel [1] called attention to certain paradoxical movements of elevation which should be mentioned in connection with this case. In paralysis of the facial nerve, when the gaze is directed downward and forced closure of both eyes is attempted an elevation of the upper lid on the paralyzed side is seen. This, according to Thurel, is a normal movement associated with elevation of the eye in Bell's phenomenon, which can be seen when the orbicularis muscle is not opposing the movement

A, patient before last operation. There is partial elevation of the left upper lid by effort of the frontalis muscle. *B*, appearance of the patient with the right eye open, showing complete ptosis on the left side. *C*, paradoxic elevation of the left upper lid during closure of the right eye.

of the levator muscle. Thurel also analyzed another paradoxic movement, occurring some time after paralysis of the third nerve and known as the sign of Fuchs. This also occurs when the gaze is directed downward and consists in a spasmodic elevation of the upper lid on the paralyzed side when the limit of downward movement on the healthy side is approached. Thurel explained it, like other forms of postparalytic hemispasm, as due to aberrant regeneration of nerve fibers, those belonging to the inferior rectus muscle in this case having grown into the branch supplying the levator muscle. It occurs only with lesions affecting the trunk of the third nerve. He considered it of essentially the same nature as the Marcus Gunn phenomenon in which fibers destined for

1. Thurel, R.: Arch. d'opht. **2**:795 and 897, 1938.

the motor branch of the trigeminal nerve have reached the oculomotor nerve.

Of more interest in relation to the present case is Thurel's discussion of "hypertonic retraction of the upper lid" in association with supranuclear paralysis of elevation or depression. This syndrome is usually due to a lesion in the peduncular segment of the brain stem, and Thurel considered a central irritation of the sympathetic fibers as perhaps responsible, resulting in hypertonicity of the smooth muscle levator.

Voisin [2] discussed Fuchs's sign, referring to several cases in which it was associated with paralysis of associated vertical movements. He would explain it through the synergy between the inferior rectus muscle and the levator muscle of the lid which manifests itself on opening the eyes after sleep. He expressed the belief that this synergistic movement may in some cases persist when elevation of the lid is otherwise impossible. Coppez [3] reported 3 cases and gave his reason for using the name sign of Fuchs in preference to that of pseudo Graefe sign which had been previously employed. He suggested that since the retraction is nearly always most marked when the patient looks down and in, origin of the aberrant innervation from the fourth nerve must be considered as a possibility. His earlier case in which the sign was due to injury of the third nerve in the orbit is considered evidence that lesions of the nerve trunk as well as of the nucleus may be responsible, although this case differed in certain respects from the typical cases.

Bielschowsky,[4] in the best article on the subject available, reported 5 cases of Fuchs's sign, called by him the pseudo Graefe sign, and reviewed other conditions somewhat resembling it. In some cases of paralysis of the oculomotor nerve retraction of the upper lid occurred only on abduction; this reaction is, of course, not uncommonly observed in cases of congenital paralysis of the abducens nerve as a part of Duane's syndrome. Bielschowsky accepted Lipschitz' theory of aberrant regeneration of nerve fibers and expressed the belief that the lesions must be in the region of the oculomotor nucleus. He [5] also described several cases of cyclic automatic spasm involving the extraocular muscles and the pupil as well as the levator muscle. These are of an entirely different nature and seem to involve pathways just above the nucleus.

While Fuchs's sign has nearly always been associated with paralysis of the third, or occasionally of the fourth, nerve, in the case of Morax [6]

2. Voisin, J.: Arch. d'opht. **1**: 896, 1937.

3. Coppez, H.: Arch. d'opht. **48**:385, 1931.

4. Bielschowsky, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 2, Leipzig, Wilhelm Engelmann, 1910, vol. 8, pt. 1, chap. 11.

5. Bielschowsky, A.: Arch. f. Ophth. **121**:659, 1929.

6. Morax, V.: Ann. d'ocul. **141**:121, 1909.

motility was almost normal, with no ptosis, and in that of Martyn [7] retraction of the upper lid when the patient looked down and in was the only anomaly present.

A peculiar phenomenon associated with paralysis of vertical movements was described by Jayle and Farnarier [8] as *spasme á bascule*. Spastic elevation of the lids occurred, suggesting the balance pans of a scale in that the right upper lid ascended when the patient attempted to look down, while the left ascended when he attempted to look up. The authors drew the conclusion that the central innervation of the movements of the lids is different when the eyes are directed above and below the midline.

In Bielschowsky's review [4] he mentioned a group of cases which resemble the present case more nearly than any others reported in the literature. All were cases of congenital palsy of the oculomotor nerve in which the Marcus Gunn phenomenon and also retraction of the paretic upper lid on closure of the normal eye were present. In that of von Reuss,[9] retraction was only partial when the patient closed the normal eye but could be made maximal when he opened the mouth. In another, that of Bull,[10] it was the same during either movement. The lid remained open during closure of the other eye. The case of Higier was apparently similar. In similar cases of Hitschmann [11] and Schapringer,[12] in which the Marcus Gunn phenomenon was also present, the reaction occurred not only when the right or normal eye closed, but when it was simply covered by the hand, the eyelid being held up for a time in Hitschmann's case after such occlusion even after the right eye was opened. Although it was stated that extraocular movements were normal in this case, it was noted that the right eye deviated up and out when the left eye was fixing, which indicates partial paralysis of the left superior rectus muscle, a condition noted in most of the other cases in addition to the ptosis. Pacetti reported 3 cases, apparently of simple ptosis, in which the lid could be opened only when the normal eye was covered. While these reports are accessible only in brief abstract, it appeared that in these cases the ptosis was not complete and that the retraction may have been a voluntary effort in the interest of vision.[13]

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7. Martyn, H. S.: Brit. J. Ophth. **3**:310, 1919.
8. Jayle, G. E., and Farnarier, C.: Ann. d'ocul. **175**:473, 1938.
9. von Reuss, A.: Wien. klin. Wchnschr. **2**:75, 1889.
10. Bull, O.: Arch. Ophth. **17**:144, 1888.
11. Hitschmann: Wien. klin. Wchnschr. **9**:1104, 1896.
12. Schapringer, A.: New Yorker med. Monatschr. **4**:10, 1892.
13. The essentials of these brief case reports are to be found in Bielschowsky's review. When possible, the originals were consulted and the references, incomplete in Bielschowsky's review, were completed.

COMMENT

The conditions discussed have nearly all occurred in persons with long-standing paralysis of the oculomotor nerve, usually after partial recovery or with congenital ptosis. Such an association also characterized the present case. In none of these cases, however, except possibly in those reported by Pacetti, did the retraction occur only when the normal eye was closed, nor was it of the same brief, spasmodic and purely automatic nature. In the cases most resembling the present one, the Marcus Gunn phenomenon was also present; however, it was absent in this case. The anomalies in all the cases of this group were congenital, while in the present case the condition was acquired. The question must arise whether the operation for ptosis was a factor in its production in this case. While it is not impossible that the operation enabled the hypothetic aberrant nerve fibers to produce this effect on the lid, it seems equally likely that it was present before but had escaped observation in a young and unruly child.

Any explanation of the abnormal reaction of the lid must be purely hypothetic. There is no doubt that a supranuclear lesion affecting vertical movements was present, and the probability is great that the paralysis of the left oculomotor nerve was due to a nuclear lesion. If the theory of aberrant regeneration of nerve fibers is accepted, and it is the most plausible one, it would seem likely that the supposed crossing of the wires occurred in the supranuclear pathway for Bell's phenomenon. The left eye being already closed, when the right eye was closed, as in sleep, in winking or in forced closure, the impulse for elevation of the eyes, ineffectual because of the paralysis of elevation, in some way reached the paralyzed levator muscle, resulting in the phenomenon described. This would not be so remarkable as the anomalous pathway from the fifth motor nerve to the levator muscle seen in Gunn's phenomenon, the only remarkable thing being that it has not been more often observed. The alternative explanation would be the one applied by Bielschowsky to the cases of von Reuss and Bull, that the aberrant fibers arose from the facial nucleus of the opposite side and were stimulated purely by the movement of lid closure on the so-called normal side. It is difficult to explain the cases in which screening the healthy eye produced the retraction, and from the brief accounts it is difficult to determine whether simple screening produced the retraction or whether it was necessary to close the lids by hand. It seems unlikely that abnormal innervation or hypertonicity of the smooth muscle levator would explain the phenomenon, on account of the height to which the lid was raised, and it is as difficult to explain such innervation of this muscle as of the striped muscle levator.

ABSORPTION LINES OF THE CORNEA

JOSEPH LAVAL, M.D.
NEW YORK

Absorption lines of the cornea have been described under various names in the foreign literature, especially by German [1] and English [2] ophthalmologists. I have found reported in the American literature only 1 case in which the condition may be of this nature, and that appeared before the use of the slit lamp. The condition is rare enough and interesting enough to warrant report and review with the purpose of giving it a definite clinical name and identity.

REPORT OF A CASE

Mrs. L. S., aged 34, was seen at Dr. Fletcher's clinic at the Manhattan Eye, Ear and Throat Hospital in October 1938, at which time she presented herself for examination for glasses. She stated that the vision of her right eye had been poor since the age of 10 years following some inflammatory lesion of this eye and also that some scarring was visible. There had been no other ocular trouble, and so far as she knew her left eye had good vision. On examination it was found that the left eye was normal in all respects, with vision of 20/20.

The vision of the right eye was 20/200 but was improved to 20/40 with a -1.25 sph. $\bigcirc -1.00$ cyl., axis 90. The diminution in vision was due to a corneal opacity which had a most peculiar appearance (*A* of the accompanying illustration). A grayish lesion involved the entire pupillary area of the right cornea, but through the opacity coursed many clear lines anastomosing with each other in many places. These clear lines were perfectly transparent, and the iris was clearly seen through them. Between the clear lines the opaque area was of unequal density, and multiple fine straight lines of clearing were seen. The opacity was quite deep, and the corneal surface was smooth and regular throughout. There was no evidence of inflammation or irritation, the eye being white. Examination and manipulation did not give rise to any signs of irritation, and the eye did not become injected.

Examination with the slit lamp was most revealing. It was clearly seen that the lesion involved only the deepest layers of the corneal stroma. Each clear line of corneal tissue had in its center a thin white line which followed the clear line

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Read before the Section of Ophthalmology of the New York Academy of Medicine, Feb. 20, 1939.

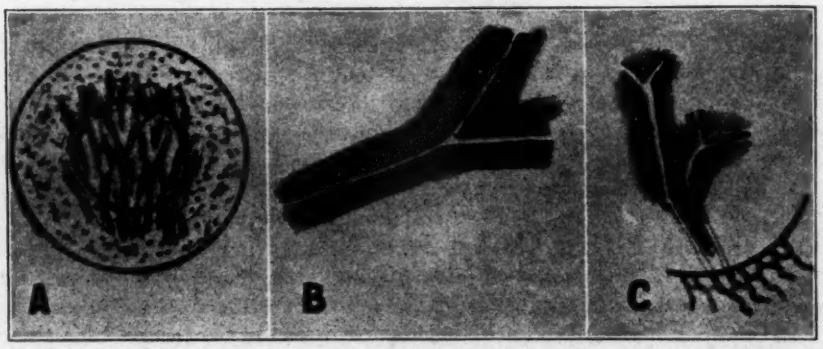
1. Kümmell, R.: Ueber die Fuchsschen Aufhellungsstreifen von Hornhauttrübungen, Arch. f. Augenh. **95**:204, 1925.

2. Spicer, W. T. H.: On the Formation of Clear Spaces in Corneal Nebulae, Brit. J. Ophth. **3**:1919. Stephenson, S.: Striate Clearing of Corneal Cicatrices, Tr. Ophth. Soc. U. Kingdom **33**:79, 1913; Striate Clearing of Corneal Cicatrices (Coarse Type), ibid. **35**:1253, 1915. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1938, vol. 2, p. 1826.

in all its anastomotic coursings (*B* of the illustration). When the white thin lines were followed to the limbus, it was seen that they were continuous with blood vessels at the limbic region below (*C* of the illustration), but in the cornea proper their lumens were closed and no blood coursed in them. This was best seen with reflected light but could easily be missed if looked for only in the region of the beam of light as it traversed the corneal layers.

REVIEW OF THE LITERATURE

In Fuchs's [2a] textbook on diseases of the eye this condition is discussed as clearing lines occurring in corneal scars. It is interpreted as always indicating a long-existing corneal scar, and the stripes in the scar are explained as "young transparent fibers arising among the old ones due to the interstitial growth of the cornea." Fuchs,[3] when he first discussed this subject in 1893, thought that the absorption lines were due to changes caused by the lymph stream in the cornea, but



Absorption lines of the cornea. The white lines represent occluded blood vessels; the gray portion, the opaque cornea, and the black lines, the clear cornea.

later in 1902 he considered that these clear lines were due to the formation of new transparent fibers laid down in the old corneal scar.

Meesmann [4] stressed the fact that this condition occurs in opacities resulting from eczematous keratitis and secondary parenchymatous keratitis, but he differentiated the latter emphatically from syphilitic interstitial keratitis. He also emphasized the fact that these lines occur only in corneal scars which have been present for many years and, further, that their true character can be determined only with the use of a slit lamp.

2a. Fuchs, E.: Diseases of the Eye, translated by E. V. L. Brown, Philadelphia, J. B. Lippincott Company, 1933, p. 216.

3. Fuchs, E.: Ueber Aufhellung von Hornhautnarben, Beitr. z. Augenh., 1893, no. 11, p. 1.

4. Meesmann, A.: Die Mikroskopie des lebenden Auges an der Gullstrandschen Spaltlampe, mit Atlas typischer Befunde, Berlin, Urban & Schwarzenberg, 1927, plate 17, fig. 60.

Metzger [5] suggested that the clear lines are due to a lipoid tissue which is deposited in the cornea at some distance from the vessels, in this way causing the opaque areas. He is supported in his contention by Winkler Prins,[6] who experimentally injected intravenously a gold salt in rabbits with corneal tuberculosis. He found that the metal was deposited in the same corneal layer where the vessels lay but at some distance from them.

Fridenberg [7] in 1895 described a condition which he called a "geometrical system of opaque lines in the cornea; an undescribed sequela of interstitial keratitis." His patient was a 30 year old woman who had interstitial keratitis and congenital syphilis, and in the deepest layers of her cornea he found a peculiar geometric formation of lines. Of course a slit lamp was not used at that time, but he did use a strong magnifying glass. He compared his case with that described by Hirschberg,[8] who also noted that these lines could look dark or light, depending on how the light was reflected from the cornea. Hirschberg was not able to give any explanation for this condition, but Fridenberg noted that the lesion lay deep below the surface of the cornea, which was clear and smooth. Fridenberg did not think that the condition was due to obliterated blood vessels and "with a strongly magnifying glass . . . could detect no trace of vascularization or of degenerated blood vessels." He thought that a collection of fat along the corneal lymph spaces was the cause of the condition, and he compared it to arcus senilis, which is also an evidence of fatty infiltration (in Bowman's membrane of the cornea).

Vogt,[9] in his "Atlas of the Slitlamp-Microscopy of the Living Eye," published in 1921, included a picture of a cornea of this type, but he did not mention the blood vessels which lie in the center of each clearing stripe. In his second edition in 1930 he described them. To Vogt, these absorption areas indicate that the scar has existed for a long time. He remarked on the striking similarity of these lines to the picture presented by folds in Descemet's membrane.

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5. Metzger, E.: Zur Entstehung der Fuchsschen Narbenaufhellungsstreifen, Klin. Monatsbl. f. Augenh. **76**:202, 1926.

6. Winkler Prins, C., Jr.: Transparent Streaks in Opaque Corneal Spots, Nederl. tijdschr. v. geneesk. **2**:2307, 1927.

7. Fridenberg, P.: A Geometrical System of Opaque Lines in the Cornea: An Undescribed Sequela of Interstitial Keratitis, New York Eye & Ear Infirm. Rep. **3**:43, 1895.

8. Hirschberg, J.: Ueber spezifische Hornhautentzündung, Centralbl. f. Augenh. **12**:254, 1888.

9. Vogt, A.: Atlas of the Slitlamp-Microscopy of the Living Eye, translated by R. Von der Heydt, Berlin, Julius Springer, 1921; Lehrbuch und Atlas der Spaltlampenmikroskopie des lebenden Auges, ed. 2, ibid., 1930, vol. 1, p. 199.

COMMENT

The cornea in the case described was of irregular thickness, and in some places a brownish pigmentation was present in the outer layers. This, I believe, is an indication of a previous severe corneal ulceration. The present appearance of the cornea is the result of absorption of some of the opacity in the region of the blood vessels. I cannot see how fatty infiltration could give this picture and, furthermore, why the fatty infiltration, if present, should be confined only to the most posterior layer of the cornea. And again, why should the infiltration be at a distance from the blood vessels? If anything, it should be close to them. However, if the opaque area is due to degeneration, fatty or otherwise, then it can easily be understood that some absorption of the products of inflammation took place in the region of the blood vessels, resulting in clear areas. This is especially true of tissues of young persons, in whom reparative processes are more active. It is significant that in all the cases reported the original corneal involvement started in childhood. No corneal opacity arising in adult corneal tissue will clear up in the characteristic manner herein described.

It is my impression that the fibers in the corneal stroma of children are less closely placed than in adults. Because of this, an inflammatory process in the cornea of children has more room between the fibers for the edema and cellular infiltration, thus resulting in less pressure on the corneal tissue fibers and, of course, less damage to them.

The radius of curvature of the cornea increases in childhood, according to von Reuss,[10] from 7.36 mm. in a child of 5 to 6 years to 7.45 mm. in a child of 12 years, and at puberty it nearly attains the average size for the adult. With the increase in the size of the cornea, the fibrillar intermediary substance develops more and more, so that the nuclear richness decreases. Accordingly, there are more wandering cells in the corneas of children and also more fixed cells. It is the wandering cells which are called on to repair damaged tissues, and the wandering cells (migratory leukocytes) come from the blood stream. The fixed cells are concerned with the corneal stroma, and the relatively greater proportion of cells in the corneas of children tends to keep the nutrition of the corneal fibers at a higher level. This greater resistance of the corneal fibers and also the larger number of the wandering cells which remove the products of inflammation are the factors, I believe, which are responsible for the absorption lines occurring in those opaque corneas which are vascularized. The word opaque is used instead of scar because the opacity is not due entirely to scarring produced by

10. von Reuss, cited by Salzmann, M.: Anatomy and Histology of the Human Eyeball, translated by E. V. L. Brown, Chicago, University of Chicago Press, 1912, p. 208.

fibrous tissue but partly to edema and inflammatory reaction. It is the opacity due to edema and inflammatory reaction which is removed along the line of the blood vessels where the nutrition of the corneal fibers is kept at a high level and also where the wandering cells are present in the greatest numbers. Accordingly, "absorption lines of the cornea" is a descriptive name and should not be replaced by "clearing lines" or any other name.

DISCUSSION

DR. RALPH I. LLOYD: I should like to ask Dr. Laval about the great number of dots scattered in the corneal periphery in one of the pictures.

DR. JOSEPH LAVAL: They were artefacts.

DR. RALPH I. LLOYD: Before any definite conclusion can be made, one should consider whether the condition is one of the three types of familial corneal dystrophy. They all begin in persons under 10 years of age. In this instance the clear lines running through the cornea look much like the lines seen in the lattice type of dystrophy. Is the condition bilateral?

DR. JOSEPH LAVAL: No, it is unilateral, and no one else in the family has this condition.

DR. JOSEPH LLOYD: Since it is unilateral, one can rule out a diagnosis of familial corneal dystrophy.

DR. PERCY FRIDENBERG: The report of my case was published under a title which was merely descriptive, that of "A Geometric System of Opaque Lines in the Cornea." I might add that these lines were absolutely rectilinear; there was not a curve anywhere to be seen. The geometric system was rather complicated; the lines were of uniform caliber throughout, and I cannot imagine any change in the wandering cells or in the fibers that could produce such a condition. In looking over the literature I have found only 1 other case at all like it. That was reported in an article by Hirschberg, in whcih he presented a drawing of remnants of blood vessels after interstitial keratitis; he explained the stripes as well as the blood vessels, which were sclerosed and in contraction and had become rectilinear.

DR. ERNST L. METZGER: In the case I reported in 1926 (*Klin. Monatsbl. f. Augenh.* **76**: 1, 1926) the absorption stripes penetrated a small opacity in the deepest layers of the cornea. Each of these clear spaces contained a patent vessel with visible circulation. It is my opinion that from these vessels lipoid is deposited in the surrounding scar tissue. As in arcus senilis, the lipoids are stored a certain distance from the blood vessel. This explains why these so-called absorption stripes appear clear in the opaque scar tissue.

THE RICKETTSIA QUESTION IN TRACHOMA

II. THE LOUSE AS A POSSIBLE DISSEMINATING AGENT FOR THE VIRUS

ALSON E. BRALEY, M.D.
IOWA CITY

Nicolle [1] in 1909 first demonstrated that lice disseminated typhus fever and succeed in transmitting the disease from monkey to monkey by the bites of infected lice. These results were quickly confirmed in other parts of the world by Ricketts and Wilder,[2] Wilder,[3] Goldberger and Anderson [4] and Wolbach, Todd and Palfrey.[5] In 1916 da Rocha-Lima [6] described small pleomorphic bodies, often bipolar staining, which he called Rickettsia prowazeki, in patients with typhus and in the gastrointestinal tract of lice fed on patients with typhus. These experiments are well known, and it has been shown conclusively that lice may transmit such acute febrile diseases as typhus, trench fever and others. When Busacca [7] described bodies in trachomatous conjunctival epithelial cells as rickettsias, it seemed natural that if trachoma is a rickettsial disease then it too should have an intermediate vector. Also, Cuénod [8]

Part of a study being conducted under a grant from the John and Mary R. Markle Foundation in the Department of Ophthalmology, State University of Iowa, College of Medicine, in cooperation with the Division of Health, Office of Indian Affairs, Department of Interior, Washington, D. C.

1. Nicolle, C.: Reproduction expérimentale du typhus exanthèmatique chez le singe, Compt. rend. Acad. d. sc. **149**:157, 1909.

2. Ricketts, H. T., and Wilder, R. M.: The Transmission of the Typhus Fever of Mexico (Tabardillo) by Means of the Louse (Pediculus Vestamenti), J. A. M. A. **54**:1304 (April 16) 1910.

3. Wilder, R. M.: The Problem of Transmission in Typhus Fever, J. Infect. Dis. **9**:9, 1911.

4. Goldberger, J., and Anderson, J. F.: The Transmission of Typhus Fever with Especial Reference to Transmission by the Head Louse (Pediculus Capitis), Pub. Health Rep. **27**:297, 1912.

5. Wolbach, S. B.; Todd, J. L., and Palfrey, F. W.: The Etiology and Pathology of Typhus: The Main Report of the Typhus Research Commission of the League of Red Cross Societies to Poland, Cambridge, Mass., Harvard University Press, 1922.

6. da Rocha-Lima, H.: Zur Aetiologie des Fleckfiebers, Berl. klin. Wchnschr. **53**:567, 1916.

7. Busacca, A.: Studii sul tracoma, Folia clin. et biol. **5**:96, 1933.

8. Cuénod, A.: Nouvelles recherches sur le trachome: Note préliminaire, Arch. Inst. Pasteur de Tunis **24**:86, 1935; Nouvelles recherches anatomiques et expérimentales sur le trachome, Rev. internat. du trachome **13**:9, 1936.

alone and with Nataf [9] described rickettsias similar to those of Busacca in the follicles and conjunctival epithelium of patients with trachoma.

With the possibility in mind that trachoma is a rickettsial disease, it seemed likely that lice should be considered as its vector, since trachomatous patients frequently are infested with these insects. Cuénod and Nataf [10] first advanced the hypothesis that lice might "carry" trachoma and subsequently reported that rickettsia-like bodies, similar to the rickettsia-like bodies of trachoma, multiplied in the body of the human louse. They [11] selected lice free from rickettsial contamination and inoculated them intrarectally with emulsions of trachomatous tissues and then demonstrated rickettsias in these lice. They [12] were able also to infect lice with these rickettsias after repeated passage through the testicles of guinea pigs. After infecting the lice, the intestine was macerated and inoculated into the eyes of monkeys with the production of conjunctivitis in each instance. In one experiment [13] laboratory-bred lice were inoculated with trachomatous material, and after several days the lice were ground and inoculated by scarification and massage into the conjunctiva of a human eye; at the end of eight days follicles and eventually typical clinical trachoma developed. From these experiments Cuénod and Nataf concluded that trachoma is a rickettsiosis and that the louse probably is its principal vector.

According to reports of public health nurses who worked on the Fort Apache Indian Reservation in Arizona, infestations of head lice were found in approximately one half of the Indian families, but it was impossible to obtain accurate data as to the exact number with lice, since no one admitted having them. Many families with lice did not have trachoma and many with trachoma did not have lice, but occasionally a family was found with both lice and trachoma, and one such family was used as a source of material.

The present studies were undertaken with the following objectives: (1) to attempt to identify and cultivate the normal rickettsial flora of the gastrointestinal tract of the louse, (2) to compare the morphologic

9. Cuénod, A., and Nataf, R.: Sur la présence d'éléments rickettsioïdes très abondants et très constants dans les follicules trachomateux, Rev. internat. du trachome **12**:110, 1935; Deuxième note sur la présence d'éléments inframicrobiens dans les follicules trachomateux, Arch. d'opht. **52**:573, 1935.

10. Cuénod, A., and Nataf, R.: Recherches expérimentale sur la contagiosité du trachome, Rev. internat. du trachome **14**:104, 1937.

11. Cuénod, A., and Nataf, R.: Recherches sur l'étiologie et la pathogénie du trachome, Rev. internat. du trachome **14**:117, 1937.

12. Cuénod, A., and Nataf, R.: Nouvelles recherches expérimentales dans la trachome, Ann. d'ocul. **174**:433, 1937.

13. Cuénod, A., and Nataf, R.: Bacteriological and Experimental Researches on the Aetiology of Trachoma, Brit. J. Ophth. **21**:309, 1937.

structure of the Halberstädter-Prowazek bodies of trachoma with that of the cellular inclusions of the louse, (3) to attempt to reproduce trachoma in baboons with lice obtained from patients with trachoma, and (4) to infect the gastrointestinal tract of the louse with trachomatous material and then test the infectivity of such lice on the conjunctivas of baboons.

MATERIAL FOR STUDY

Head lice were obtained from patients with active trachoma. Conjunctival smears from these patients contained many inclusions, and in a lone experiment material from one of them was infectious for a baboon. Most of the lice (Pediculus humanus) were of the capitis

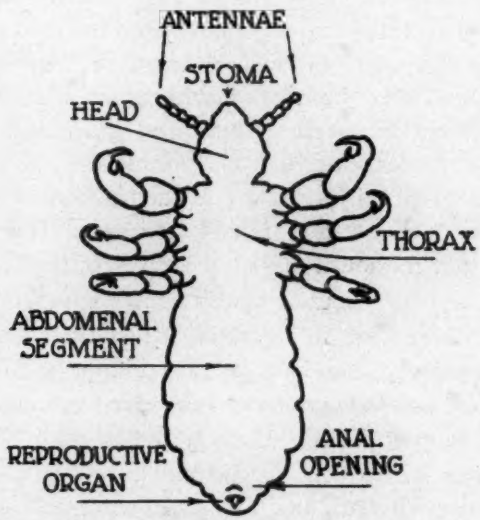

Fig. 1.—Male head louse, ventral view.

variety; however, both variety capitis and variety corporis "can interbreed, and are, therefore, not distinct species." [14]

Pediculus humanus obtained from the Indians showed the following regional characteristics:

The head is short, relatively broad and somewhat conical, with an abrupt constriction near the beginning of the thorax (fig. 1, ventral view). The stoma of the louse is quite small; the upper labia is somewhat overhanging, and on it may be two or more short spinelike processes that seem to represent teeth. These are sometimes called clinging or fixing teeth; they are usually everted and are brought into action as the louse feeds. The proboscis protrudes from the stoma when the insect feeds.

14. Patton, W. S., and Evans, A. M.: Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance, Croydon, H. R. Grubb, Ltd., 1929, pt. 1.

There are three thoracic segments, each bearing a pair of legs articulating on the lateroventral surface.

The abdomen is elongated and flattened dorsoventrally. It is distinctly segmented and is usually widest at the third and fourth segments. There are seven distinct segments and in addition a distal segment, which is round and blunt in the male and forked or V shaped in the female. On the ventral side of the female at the junction of the seventh

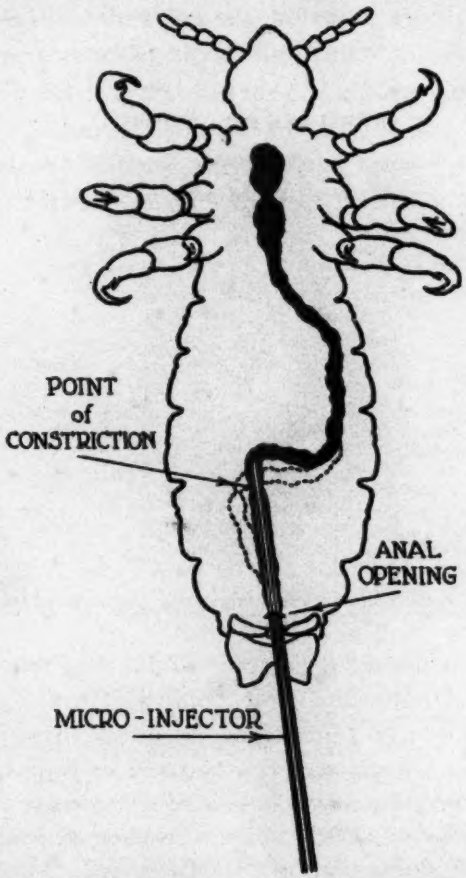

Fig. 2.—Female head louse with microinjector in place.

and the eighth segment are too heavy spines that usually meet in the midline; these are known as gonopods and cover the opening of the reproductive organs of the female. In both the male and the female the anal opening is near the middle of the seventh segment; it is seen as a slight fold in the tegmentum and is often difficult to find (fig. 2). In the male the reproductive organ, the adeagus, is usually rather prominent, protruding from the opening of its sheath near the junction of the seventh and the terminal segment.

The gastrointestinal tract of the louse is relatively simple. It usually contains blood or brown pigment and shows up well in the living insect. The stoma leads to the first pharynx, the first pharynx to the second pharynx and the second pharynx to the thin esophagus which unites with the midgut in the thorax. The midgut extends into the abdomen and may or may not almost fill the entire cavity. When the louse has just fed, the entire abdominal cavity seems to be occupied by the gut, but after various periods of starvation the gut shrinks in length. According to Patton and Evans,[14] the gut is about twice as long as the louse.

EXPERIMENTAL STUDIES

Group 1.—Several hundred live head lice smeared directly on slides were allowed to dry in the air and were stained with Giemsa's stain in an attempt to demonstrate rickettsias.

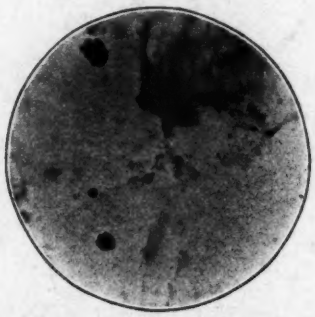

Fig. 3.—Free rickettsia-like bodies from the fecal material of a louse

Results.—Approximately 8 per cent of lice are reported to harbor rickettsias in the gastrointestinal tract,[5] but less than 1 per cent of the lice found on the American Indians contained rickettsias. A few smears showed extracellular collections of rickettsia-like bodies, but no intracellular collections were found. These bodies stained red with Giemsa's stain (fig. 3) and may be closely allied to Rickettsia pediculi. Bacteria were present in the smears, mostly staphylococci. When ground lice were cultured on blood agar mediums only Staphylococcus albus grew. No bodies could be found that simulated the Halberstädter-Prowazek bodies or initial bodies of trachoma. Conjunctival epithelial smears of patients from whom the lice were obtained contained typical Halberstädter-Prowazek inclusion bodies.

Group 2.—In each of the 20 experiments of this group 10 to 30 lice were removed from the head and carefully placed in a test tube. In most instances the lice were unselected, but in one experiment only females were used, in another only males, while in still another only the first and second nymphs. In each experiment the live lice were placed in a small amount of sterile physiologic solution of

sodium chloride or Tyrode's solution and carefully macerated; the suspension was then inoculated on the conjunctivas of baboons. The conjunctiva of each baboon was anesthetized with butyn or pontocaine hydrochloride, and the suspension of macerated lice was placed on the conjunctiva and rubbed briskly with either a cotton-wound applicator or a sterile platinum spatula. Daily observations were made for signs of conjunctivitis. On the day after inoculation there was moderate redness of the conjunctiva, and considerable débris had collected at the inner canthus, but in every instance the conjunctiva was normal on the second day and remained so throughout an observation period of six days to three weeks.

Results.—In none of the 20 eyes of baboons inoculated with ground lice from trachomatous patients did conjunctivitis develop. The material transferred from the conjunctiva of the same patients produced an active experimental trachoma in baboons.

TABLE 1.—*Results of Experiments in Group 3*

No. of Experiment	Age of Embryo When Inoculated, Days	Days Between Inoculation and Reopening Egg	Comment
1	14	7	Smears made at point of inoculation
2	10	7	Smears made at point of inoculation
3	10	7	Embryo dead; smears made
4	10	7	Smears made at point of inoculation
5	10	7	Smears and sections made of inoculated area
6	9	7	Embryo dead; smears made
7	6	7	Embryo dead; no gross lesions
8	5	7	Embryo dead; no gross lesions
9	5	7	Embryo dead; no gross lesions
10	7	7	Embryo dead; no gross lesions

Group 3.—In each of 10 experiments live lice were collected and ground in sterile physiologic solution of sodium chloride or Tyrode's solution. Under aseptic conditions a small window was made into an incubated egg, and the shell membrane was carefully opened, exposing the chorioallantoic membrane. This membrane was then inoculated with ground lice in an effort to cultivate any rickettsias present in the body of the louse. The chick embryos, ranging in age from 5 to 14 days, were all alive and in good condition when the chorioallantoic membranes were inoculated. All eggs were examined at the end of seven days, and smears or sections were made of the site of inoculation. Six embryos were dead when the eggs were opened, while 4 were still alive. The results of these experiments are shown in table 1.

Results.—Six of the inoculated chick embryos died, smears from which showed only staphylococci and degenerated cellular débris. Four of the embryos remained alive, and smears from the inoculated areas showed young connective tissue cells, epithelium from the chorioallantoic membrane and louse débris. No rickettsias were found. Sections of the chorioallantoic membrane showed moderate hyperplasia of the epithelium at the site of inoculation but no evidence of rickettsias.

Group 4.—In the 5 experiments in this group lice obtained from both trachomatous and nontrachomatous patients were divided into two groups, one for control and the other for inoculation. Cotton moistened with physiologic solution of sodium chloride, human hair and cotton applicators soaked in blood were placed in test tubes and the lice deposited in these tubes.

Trachomatous conjunctival scrapings were obtained from a conjunctiva infective for a baboon, suspended in Tyrode's solution, ground in a mortar and placed in the microinjector of the micromanipulator (fig. 4). A small amount of the material was ejected from the capillary pipet onto a slide for staining, in order to demonstrate the presence of free elementary and initial bodies and inclusion bodies in conjunctival epithelial cells. A louse was then placed, ventral side up, on a slide smeared with petrolatum and gently held with the left hand manipulator pipet,

Fig. 4.—Micromanipulator used for injection of lice; Zeiss microscope and Fritz Bausch-Lomb micromanipulator.

TABLE 2.—*Results of Experiments in Group 4*

No. of Experiment	No. of Lice	Hours of Life	Results
1	2	48	No conjunctivitis in 10 days
2	3	72	No conjunctivitis in 12 days
3	5	48	No conjunctivitis in 11 days
4	5	48	No conjunctivitis in 14 days
5	5	48	No conjunctivitis in 14 days

after which the micropipet was forced into the anal opening well beyond the point of constriction at the junction of the midgut and the rectum. The entire contents of the gastrointestinal tract were washed out, and the trachomatous material was injected and allowed to remain. These lice were then returned to the

test tubes. After this the remaining solution in the microsyringe was ejected onto a slide and stained. Twenty lice were inoculated in this manner at different intervals. As soon as half the lice in the control group were dead, the inoculated lice were ground and inoculated on the conjunctivas of baboons, the same as in group 2. The mortality of the inoculated lice was the same as for the control lice. The lice were allowed to live from forty-eight to seventy-two hours before they were inoculated on the conjunctivas of baboons. The results of these experiments are given in table 2.

Results.—Twenty lice were given intrarectal inoculation of known trachomatous material. In none of the 5 baboon eyes inoculated with these lice did conjunctivitis develop; however, the material used for injection produced experimental trachoma in a baboon.

COMMENT

Head and body lice show similar characteristics; they interbreed, disseminate typhus fever, spotted fever and other diseases [15] and should be considered the same species. At times lice are known to harbor rickettsias, as shown by Wolbach, Todd and Palfrey, Nicolle, da Rocha-Lima, Weigl, Ricketts, von Prowazek and others; these inhabitants usually stain red with Giemsa's stain, are mostly extracellular and may be closely allied to the rickettsias of trench fever but are usually considered as nonpathogenic. In this study approximately 1 per cent of the lice from trachomatous and nontrachomatous Indian patients contained rickettsias, none of which could be grown on the chorioallantoic membrane of the chick embryo.

Cuénod and Nataf's results appear to incriminate the louse as an important vector in trachoma, but in these experiments ground lice from trachomatous patients did not produce conjunctivitis in baboons.

Weigl's [16] method of intrarectal inoculation of lice is the most widely used in research on typhus fever. By this method the material is placed in the rectum and may or may not get into the midgut of the louse. In contrast to this, the method used here placed trachomatous material containing free elementary and inclusion bodies in the midgut of the louse; however, in spite of the careful placement of infected material, the macerated bodies of these lice did not produce conjunctivitis in baboons. No rickettsias or inclusion bodies were found in a smear made of the lice. The trachomatous infected material must have been destroyed in the gastrointestinal tract of the louse in a short time, since no evidence of the virus was found at the end of forty-eight hours. An occasional

15. Matheson, R.: Medical Entomology, Springfield, Ill., Charles C. Thomas, Publisher, 1932.

16. Weigl, R.: Der gegenwärtige Stand der Rickettsia-Forschung, Klin. Wchnschr. **3**:1590 and 1636, 1924.

degenerated conjunctival epithelial cell was encountered in the smears, but none showed inclusions. Neither was the virus present in the "blood stream" of the louse or in its colonic cavity, since the entire louse was macerated and inoculated.

Experiments are being continued in an effort to find a strain of trachoma virus which will reproduce in the intestinal tract of the louse and produce conjunctivitis in baboons.

Unless the virus passes through a definite cycle in the body of the louse, during which time it is noninfectious for baboons, it appears that the louse is not a vector in trachoma and does not transmit the disease. The body louse, tick and flea of man and baboon are being investigated as possible vectors of the disease.

CONCLUSIONS

1. Less than 1 per cent of lice removed from Indian patients with trachoma show rickettsias in the gastrointestinal tract.

2. The rickettsias in a few lice, because of staining reaction and morphologic structure, appear to be rickettsias of the louse (Rickettsia pediculi).

3. Morphologically, no bodies found in the louse even vaguely suggest the Halberstädter-Prowazek bodies.

4. Ground lice from Indian patients with trachoma do not transmit conjunctival disease to baboons.

5. No rickettsias grew on the chorioallantoic membrane of the developing chick embryo.

6. Trachoma virus in the gastrointestinal tract of the louse disappears within forty-eight hours.

7. Ground lice infected with trachomatous material do not produce conjunctivitis in baboons.

FAMILIAL RETINAL DEGENERATION LEADING TO DETACHMENT AND CATARACT FORMATION

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I have been privileged to observe over a period of several years a family whose members present a set of clinical manifestations which to my knowledge are unique in ophthalmology. These clinical data pertain

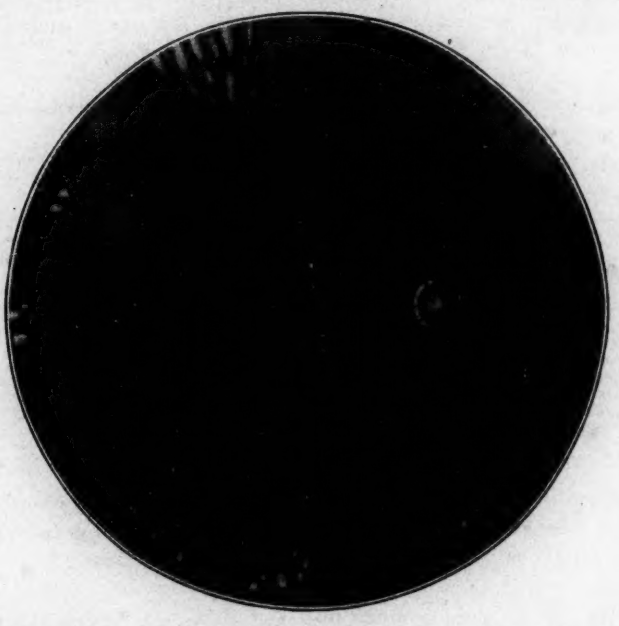

Fig. 1.—Fundus picture. The lesion in the upper portion of the fundus appears elongated due to astigmatic distortion.

first to the skeletal system and secondly to the eye proper. Whether there is a correlation between the general and the local characteristics cannot be stated convincingly.

The family consists of a mother and 7 children—5 females and 2 males. All the offspring except the oldest bear a remarkable resemblance to the mother, who has the facies common to hyperpituitarism. They possess a large heavy-boned framework and exhibit a prominent lower jaw; the cheekbones are high, the orbits widely separated, and the teeth unevenly spaced.

Two of the sisters have been studied in detail from the point of view of the internist, but aside from the diagnosis of "hyperpituitary type" the information

From the Knapp Memorial Eye Hospital.

obtained has been of a negative nature. Roentgen examination of the skull, Wassermann tests of the blood and general chemical examinations, including determinations of calcium, urinalysis and basal metabolism readings, gave results within normal limits.

All members of the family except the oldest child have myopic astigmatism requiring a correction averaging about a — 3.00 D. sphere ⌒ — 2.00 D. cylinder, axis near the horizontal meridian. All the visible fundi are affected by a peculiar form of peripheral retinal degeneration, and in all but 2 of the children so affected there have occurred either complicating cataracts or retinal detachments or both. There is one exception; the oldest child has normal fundi.

Examination of the fundi of these patients showed the lesions to be located in the extreme periphery. They might easily be overlooked in an examination through the undilated pupil, particularly if their presence were unsuspected. The lesions were of two main types—small yellowish white islands of degeneration and larger irregular sheets of whitish degeneration. The islands appeared to involve the deeper retinal layers but not the choroid. For the most part they tended to

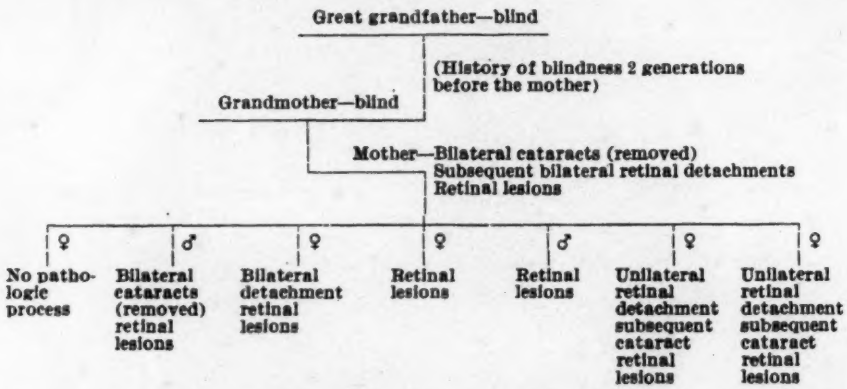

Fig. 2.—Family tree. (The third child was not under my observation. Through Dr. Merrill J. King, of Boston, I learned that bilateral retinal detachment occurred and that the patient possessed the characteristic retinal lesions.)

remain isolated, but in some regions they had coalesced. Their diameters rarely exceeded one third of the disk diameter; most of them were much smaller. A slight amount of pigment in the form of small dots was seen around these islands. Linear arrangement of pigment was rare, and neither the lesions nor the pigment seemed to follow the blood vessels. Pigment hypertrophy was not present anywhere in large amounts. In some instances the islands seemed to have resolved into small retinal cysts, and in 2 patients a circular retinal hole was visible. The retina surrounding the hole was flat, and no detachment was discernible, but undoubtedly such a hole is the explanation for the detachments in the other patients.

The sheetlike lesions were larger and appeared to involve only the superficial layers of the retina. They were milky white and irregular. Their area was about one-half to one and one-half times that of the disk. They were usually unattended by pigment formation and appeared stretched, like very early bands of retinitis proliferans; in no instance, however, have I observed true proliferating strands, not even in the long-standing detachments.

The lesions of the fundus began in the periphery and progressed slowly inward, but not far. The central two thirds of the retina appeared free from pathologic changes.

The vitreous in all cases in which it could be studied was degenerated and contained freely movable opaque strands. Slit lamp examination of the corneas showed no deposits.

The family tree (fig. 2) indicates the complications in the members of the series.

A history of trauma to the eye or head antedated the detachments in 3 of the children. The violence of the injury was not marked, indicating, as one might suppose, the predisposition of such eyes to traumatic detachments of the retina.

SUMMARY

A mother and 7 children were studied, and all but the oldest child were found to have peripheral retinal lesions. Two patients of those showing retinopathy have thus far escaped complications. All the others have either cataract or detachment or both. I have no means of knowing how early in life the retinal lesions make their appearance as all the patients were adults.

All the affected patients have the general characteristics of hyperpituitarism. It is noteworthy that the oldest child, a female, does not resemble the rest of the family in appearance and has inherited no ocular pathologic process.

CYCLOPLEGICS

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AND
HENRY S. MURPHEY, M.D.
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The basic factor to be considered when selecting a cycloplegic for refraction is the depth to which it will depress accommodative power without deleterious effect. Secondary factors to be considered are the speed with which the maximum depression is reached, the length of time it is maintained and the speed of complete recovery therefrom.

The ideal cycloplegic is apparently nonexistent. One that will totally abolish accommodation has not been reported. One that is easily administered usually results in inconsistent depression of accommodation, a part of which is due to carelessness relative to administration and to unruly patients and not entirely to the drug itself.

Atropine sulfate ($[C_{17}H_{23}NO_3]_2H_2SO_4$), probably the best cycloplegic available, and scopolamine hydrobromide ($C_{17}H_{21}NO_4HBr_3$) are toxic, and considerable care must be exercised in their administration. It is customary to instil atropine sulfate in the eyes of children two or three times daily for three or four days prior to refraction when striving to obtain the best results, and the return of accommodation to its normal power requires ten to fifteen days. The atropine alkaloid ($C_{17}H_{23}NO_3$), while a powerful mydriatic and cycloplegic, is too painful and irritating to be used as a routine, or in any case for that matter.

Homatropine hydrobromide or tropine mandelate ($C_{16}H_{21}NO_3HBr$) is the hydrobromide of an alkaloid prepared from tropine, a base obtained in the breaking down of atropine. This drug, the most extensively used cycloplegic for adults, was first employed as such in 1881 and was admitted to the "British Pharmacopeoia" in 1890. In the twenty-first edition of the "Dispensatory of the United States" [1] it is stated: "After the instillation of a one per cent solution the pupil begins to dilate in from seven to twenty minutes and accommodation fails in from forty to ninety minutes, while recovery is complete in from three to four days."

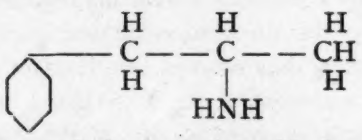
From the Medical Corps, United States Army.
Read before the Washington, D. C., Ophthalmological Society, Jan. 9, 1939.

1. Wood, G. B.: The Dispensatory of the United States of America, ed. 21, edited by H. C. Wood Jr., C. H. LaWall and others, Philadelphia, J. B. Lippincott Company, 1926, p. 2.

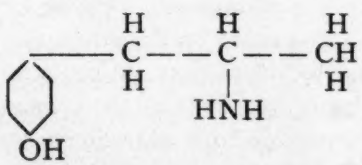
It is certain that the detailed effects of this drug on accommodation, from the time of instillation to complete recovery therefrom, have been reported at some time since its introduction, but we have been unable to find reports of such investigations. Today the drug is instilled in the eye in varying strengths, the most common being the 2 per cent solution and the amount instilled being from 4 to 6 drops at intervals of three to fifteen minutes. Three, 4 and 5 per cent solutions are employed by many oculists.

Experience has taught that homatropine is practically nontoxic when instilled in the eye; it has no significance relative to intraocular pressure in the nonglaucomatous eye; it does not totally abolish accommodative power in the average eye, and in a percentage of eyes, sufficiently large to be troublesome, a considerable amount of residual accommodation is encountered. Because of its failure to depress accommodation to the minimum in all instances, the multiplicity of instillations generally employed and the long recovery period, oculists are constantly on the alert for a more efficient and more easily administered cycloplegic that may be employed in routine refractions.

Benzedrine in the form of the sulfate in a 1 per cent solution has been introduced as an adjunct to atropine and homatropine cycloplegics. The formula [2] for benzedrine is:



Paredrine [3] in the form of the hydrobromide in a 1 per cent solution has been recommended for the same purpose and is claimed by its manufacturers to be as efficient as benzedrine. The formula [2] for this drug is:



These drugs are assumed to enhance the action of atropine and homatropine by hastening the onset of the paralysis, increasing the depth of the same, reducing the time of recovery and improving in general the efficiency of retinoscopic examination.

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2. This formula was supplied by the Smith, Kline and French Laboratories, Philadelphia.

3. Paredrine is a proprietary name for a sympathomimetic drug (4-hydroxy-α-phenyl-β-aminopropane; β-4-hydroxyphenylisopropylamine).

Beach and McAdams [4] have reported favorably on the action of the benzedrine-homatropine cycloplegic, and we have encountered several oculists who report favorable results. However, the reports concerning the efficiency of the combination are not entirely conclusive in that they do not cover the entire phase of reaction from the time of instillation to complete recovery of accommodation. They failed to show exactly to what extent accommodation is depressed, the length of time depression is maintained or the approximate time of complete recovery from the effect of the drugs.

According to the report of Myerson and Thau,[5] benzedrine is a powerful adjunct to atropine when employed as a cycloplegic, and Beach and McAdams concluded that the same would apply to homatropine. Theoretically these conclusions should be correct if a dual innervation of the muscles of accommodation actually exist.

It is an accepted fact that in regard to the motor innervation of the iris the circular muscle bundle is activated by parasympathetic nerve fibers conveyed to it by way of the third nerve, the stimulation of which induces miosis. The radial epithelial muscle cells are activated by sympathetic nerve fibers conveyed to them by way of the ciliary ganglion or nasociliary nerve; the stimulation of these induces mydriasis.

It is a generally accepted fact that the circular bundle of the ciliary group is innervated by parasympathetic nerve fibers conveyed to it by way of the third nerve, the stimulation of which induces accommodation for near objects. Cogan [6] has revived the theory that the radial bundles of the ciliary group of muscles are innervated by sympathetic nerve fibers conveyed to them by way of the ciliary ganglion or nasociliary nerve, the stimulation of which induces accommodation for remote objects (relaxation of accommodation). Accommodation for remote objects according to this theory is, therefore, an active and not a passive function, as was formerly maintained. Under normal conditions one innervating system acts as a brake on the other, and paralysis or destruction of one is followed by overaction of the other. Thus, the administration of a drug inducing paralysis of the sympathetic nervous system would be followed by miosis and extreme accommodation for near objects, while one inducing paralysis of the parasympathetic nervous system would result in mydriasis and accommodation for remote objects.

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4. Beach, S. J., and McAdams, W. R.: Benzedrine in Refraction: Preliminary Report, Tr. Am. Ophth. Soc. **35**:221, 1937; Benzedrine in Cycloplegia: Further Report, Am. J. Ophth. **21**:121 (Feb.) 1938.

5. Myerson, A., and Thau, W.: Human Autonomic Pharmacology, Arch. Ophth. **18**:78 (July) 1937.

6. Cogan, D. G.: Accommodation and the Autonomic Nervous System, Arch. Ophth. **18**:739 (Nov.) 1937.

Benzedrine sulfate has been shown to act adrenergically on the eye in all respects;[5] in short, it stimulates the sympathetic nerve endings. Atropine and homatropine depress the action of the parasympathetic nerve endings and stimulate the sympathetic nerve endings. These drugs act by interrupting the transmission of impulses from the nerve to the reacting cell. The statement of Myerson and Thau[5] in reference to atropine, that it "directly changes the chemical reactions which take place between the reacting cell and the acetylcholine, so that the effects of the latter are warded off or abolished," is true of these drugs. The acetylcholine is assumed to bring about whatever activity is produced by stimulation of the parasympathetic nerves.

In a report of an investigation of paredrine hydrobromide Abbott and Henry[7] stated: "In the eye it appears to be a harmless, but effective, mydriatic of rather evanescent action, and perhaps advantageous for use in temporarily dilating the pupil." No mention is made in their report of the action of the drug on accommodation.

When a cycloplegic is administered, the transmission of parasympathetic impulses is interrupted, thus removing the brake on sympathetic activity, which is responded to by contraction of the radial muscles of the iris and, if a dual innervation actually exists, of the ciliary body as well, with relaxation of the circular muscle bundles in these structures, thereby inducing mydriasis and depression of accommodation for near objects. As benzedrine and paredrine are sympathetic stimulants, it is possible that mydriasis and cycloplegia will follow more quickly and be more profound when these drugs are administered with atropine and homatropine, which are in themselves sympathetic stimulants. Also, as sympathetic activity acts as a brake on parasympathetic activity, stimulation of the sympathetic nerve endings with benzedrine or paredrine would prolong the recovery of accommodation unless the action of these drugs is fleeting and is followed by a period of depression of sympathetic activity. If a dual innervation of the ciliary muscles does not exist, as is maintained by many oculists, it is difficult to visualize benzedrine or any other adrenergic drug influencing accommodation in any way.

Factors to be considered in determining the efficiency of a cycloplegic are: the depth to which it will depress accommodation, the reliability and speed of its action, the period of time depression is maintained and the time required for complete recovery.

In order to measure with any degree of accuracy the actual amount of accommodation exerted, the eyes must be emmetropic or made so

7. Abbott, O. W., and Henry, C. M.: Paredrine: A Clinical Investigation of a Sympathomimetic Drug, Am. J. M. Sc. **193**:661 (May) 1937.

with the proper correcting lenses and all measurements made with such corrections. The necessity for this is obvious and does not call for a detailed explanation.

PURPOSE AND METHOD OF INVESTIGATION

In this investigation of cycloplegics it was decided to confine our efforts to a determination of their effect on the power of accommodation as a primary objective. Retinoscopic examination was not considered a primary objective, but it was done as a routine on all eyes investigated. The possibility of benzedrine and paredrine increasing the accuracy and ease of accomplishment of this examination, other than by their action on accommodation, was not seriously considered, as such factors are appreciated, to a greater or lesser degree, by the individual examiner. The effect of the cycloplegics on intraocular pressure was not determined for all eyes. For the first 40 eyes examined the pressure was determined before the instillations were made and after the retinoscopic examination was completed; these determinations were then discontinued as a routine procedure for the remaining eyes. All eyes investigated were emmetropic or were made so with correcting lenses as determined by retinoscopic examination, and the vision in all eyes was 20/20 or was corrected to this degree. All instillations of cycloplegics, with the exception of those for the first series of eyes investigated, were made with the utmost care. The patient was seated with the head tilted backward or was placed in a reclining position; the upper lid was raised, the globe rotated downward and the drug allowed to flow over the surface of the cornea. The eye was maintained in this position for an appreciable length of time. When the drug was accidently flicked from the conjunctival sac the data were discarded and do not appear in this report.

All measurements were made with an accommodation rule, a modification of that designed by Prince, bearing a scale whereon the accommodative power was indicated in diopters. The rule was also equipped with a slide on which was mounted two cards, one for each eye, and bearing letters equaling in size Jaeger's test type 1. The test card was placed near the eye to be examined, with the nosepiece of the rule resting on the bridge of the nose. The card was then carried slowly away from the eye until the letters were in sharp focus. The amount of accommodative power exerted to accomplish this was read off the scale in diopters.

This method of measuring accommodative power constitutes one with a fixed object and a variable distance. The results of this method were compared with those obtained wherein a fixed distance and variable objects were employed. There was little difference in the results obtained, and the former method was adopted as a routine as being the more practicable. These methods have the disadvantage of being subjective tests and are therefore subject to errors, for which the examiner

must be constantly on the alert. The principal error encountered was that the examinee would invariably read the letters as near to the eye as possible and without waiting to attain a sharp focus. This tendency was constantly guarded against, and at each sitting several trials were frequently necessary to avoid this error. Obviously, the position of sharpest focus is the one on which the eye is actually exerting its greatest efficient accommodation and is the point searched for. Any position before or behind the point of sharpest focus cannot be the focal point.

The eyes observed for this investigation of the action of cycloplegics were, for convenience, divided into four series.

FIRST SERIES

The first series was comprised of eyes on which routine refraction was done. No requirements were necessary for selection other than a visual acuity of 20/20

TABLE 1.—*Pertinent Findings and Facts Relative to the Eyes Comprising the First Series*

Cycloplegic	No. of Eyes Examined	Residual Accommodation (Diopters)			Ages Represented			Interval Between Instillations and Retinoscopic Examination (Minutes)		
		Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average
Benzedrine-homatropine.....	72	5.00	0.25	1.52	58	11	30	170	50	85
Homatropine 2% (regular)..	72	5.75	0.12	0.87	57	11	40	80	50	72

with or without correction. Refraction was done on 72 eyes under cycloplegia with the benzedrine-homatropine combination. One drop of a 5 per cent solution of homatropine hydrobromide was instilled, followed in three minutes by 1 drop of a 1 per cent solution of benzedrine sulfate. Refraction was also done on 72 eyes under cycloplegia with the regular 2 per cent solution of homatropine hydrobromide, a total of 4 drops of which was instilled (1 drop every three minutes). The patients were required to wait at least fifty minutes, after which retinoscopic examination was performed when possible, the exact time being dependent on the number of miscellaneous examinations and treatments to be carried out. Consequently, a definite time was not set for retinoscopic examination, and the time interval between instillations and the measurement of the residual accommodation varied considerably, as shown in table 1. Eventually retinoscopic examination was accomplished, the correction was fitted and the residual accommodation was then determined. The time of recovery of accommodation was not determined other than by statements of the patients concerned. All instillations were made at or about 1 p. m.

Results.—A summary of the pertinent facts and findings of interest in the two groups comprising this series are presented in table 1, and

the residual accommodation found in each instance on completion of retinoscopic examination and trial frame correction are presented in chart 1.

The findings with this group of eyes do not offer a great amount of conclusive information. The residual accommodation at the time of retinoscopic examination and trial frame correction is presented, but this does not necessarily represent the lowest point to which accommodation was depressed. The measurements were made at irregular intervals, and the findings, therefore, are not consistent. However, it does demonstrate that the regular homatropine cycloplegic depressed accommodation to a lower level and in a more consistent manner than did the benzedrine-homatropine combination in patients on whom refraction

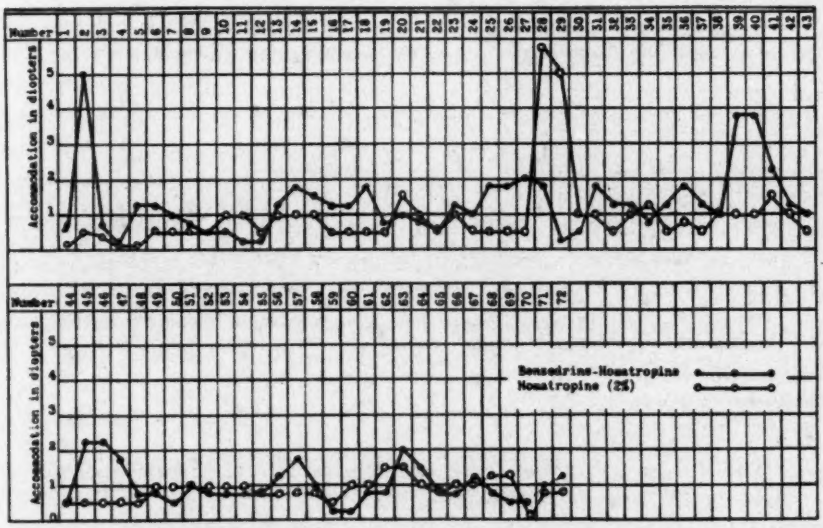


Chart 1.—Graphic presentation of the residual accommodation found in 144 eyes (first series) at time of retinoscopic examination.

was done in a more or less haphazard manner in regard to the time element, as practiced in most busy clinics. The average residual accommodation of the 72 eyes for which the benzedrine-homatropine combination was used was 1.52 diopters and that of the eyes for which the regular 2 per cent solution of homatropine hydrobromide was used was 0.87 diopter.

In regard to the recovery time, 63 per cent of the patients examined stated that their eyes were again normal before retiring that night; 30.6 per cent reported that they were normal on arising the following morning, and for 6.4 per cent more than twenty-four hours elapsed before their eyes were reported as normal.

For those eyes showing a high residual accommodation (charts 1, 2, 28, 29, 39, 40, 45, 46 and 63) several additional drops of the cyclo-

plegic were instilled, but the drugs had no appreciable effect in lowering this accommodation.

The inconsistent action of the benzedrine-homatropine combination may well be due, in part at least, to the method of instillation, as there was no particular care exercised in this respect. Instillations of the regular homatropine were made in the same manner, but the multiplicity of drops could readily have compensated for the lack of care.

METHOD OF STUDY FOR SERIES 2, 3 AND 4

The method of investigating those eyes falling in the second, third and fourth series is outlined herewith:

The patients were, in general, young soldiers and members of the Civilian Conservation Corps, enrollees in the hospital for minor ailments and awaiting return to their respective organizations, this type of patient being the most readily available. Visual requirements were the same as before. Examinations were started at or about 8 a. m. The power of accommodation was determined, the cycloplegic instilled and the power of accommodation again determined, at intervals of fifteen minutes, for two or two and a half hours. If retinoscopic examination and trial case correction had not been previously accomplished, they were done at the end of ninety minutes after the instillations, and all former measurements of accommodation were corrected from these findings. All measurements from this point forward were made with the required correction worn. After the two and a half hour period measurements were made every hour until 4 p. m., then again at 6 and 8 p. m. If accommodation had not reached its normal level by 8 o'clock, it was again measured at 8 o'clock the following morning and every two hours throughout the day until it was normal. As there appears to be considerable variation of accommodative power under normal conditions, a reading within 0.75 diopter of the precycloplegic power was considered a complete return of accommodation. There were some variations from the foregoing routine from time to time, but it was adhered to as closely as circumstances permitted.

Those eyes showing a reading below normal at the last evening measurement but a normal reading the following morning obviously reached normal at some time during the night. They were, however, recorded as having reached normal at the time of the last examination. Because of this, the average recovery time reported is not as accurate as could be hoped for. The number of eyes to reach normal during the night are recorded in table 4. In the investigation of the last series the fifteenth minute measurements were terminated at the end of two hours instead of two and a half.

Apparently the time of complete recovery of accommodation is not of paramount importance to the average person falling in the age group represented in this investigation. It was noted that during the recovery period the patients, with few exceptions, stated that their eyes were again normal when accommodation reached the vicinity of 3 diopters. The exact point of apparent recovery was influenced, of course, by the type and amount of refractive error exhibited and by the sensitivity of the patient concerned.

Furthermore, inspection of the charts will show that twelve hours after the instillations, irrespective of the kind or amount of cycloplegic employed, accommodation was sufficiently restored for the patients to perform ordinary close work.

The highest hypermetropic error exhibited in these series was 2 diopters, the highest myopic error was 0.50 diopter and the highest astigmatic error was 0.75 diopter.

SECOND SERIES

The second series consisted of 46 eyes, in 23 of which was instilled the benzedrine-homatropine combination (a total of 2 drops of 5 per cent solution of homatropine hydrobromide and 1 drop of 1 per cent solution of benzedrine sulfate) and in the remaining 23 eyes a total of 6 drops of a 2 per cent solution of

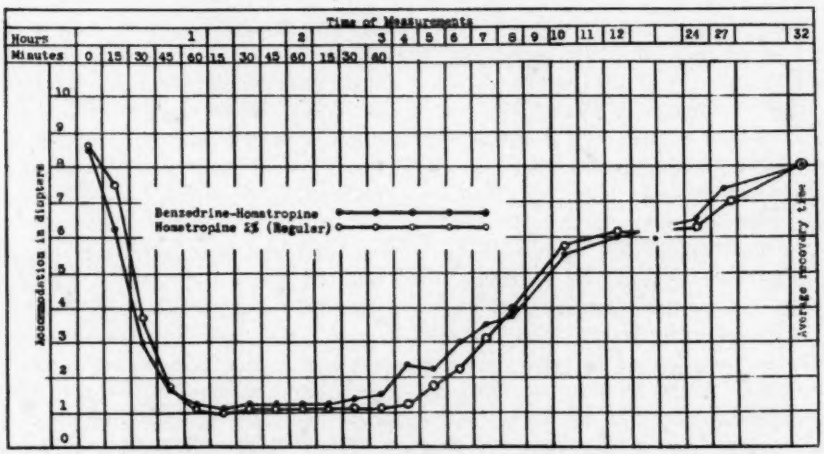


Chart 2.—The depression of accommodation and recovery time following the instillation of the benzedrine-homatropine combination and of a 2 per cent solution of homatropine hydrobromide. Each curve represents the average accommodation of 23 eyes.

homatropine hydrobromide (1 drop every ten minutes). In 6 instances the benzedrine-homatropine combination was instilled in both eyes, and ten days to two weeks later the regular 2 per cent solution of homatropine hydrobromide was instilled. For the remaining tests the benzedrine-homatropine combination was instilled in one eye and the 2 per cent solution of homatropine hydrobromide in the other. The former method was not well received by the patients concerned and for this reason was discontinued.

The average accommodative power of the 46 eyes comprising this series was determined at the intervals previously mentioned. The average recovery time was also determined, and a composite graph of the findings in each group was plotted as shown in chart 2.

Results.—A study of chart 2 and of tables 2, 3 and 4 will show that there is not much choice between the benzedrine-homatropine combina-

tion and the regular 2 per cent solution of homatropine hydrobromide so far as the basic requirement of a cycloplegic is concerned. Accommodation was depressed equally in both groups; the amount of residual accommodation was nearly the same, the regular homatropine having a slight advantage in this respect; recovery began in two hours and fifteen minutes with the benzedrine-homatropine combination and in three hours with the regular homatropine, and the average time of complete recovery was the same in both groups. It will be noted that the lowest average residual accommodation was 1 diopter with the regular homatropine and 1.12 diopters with the benzedrine-homatropine combination. Undoubtedly, there would have been some difference in the recovery time in the two groups had the measurements been continued throughout the night in those eyes failing to reach normal during the day.

TABLE 2.—*Summary of Pertinent Facts and Findings Obtained with Eyes Investigated in Series 2, 3 and 4*

Cycloplegic	No. of Eyes Examined	Residual Accommodation (Diopters)			Recovery Time (Hours)			Ages Represented		
		Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average
Homatropine, 2% (regular).	23	2.00	0.50	1.00	49	12	32	39	17	22
Benzedrine-homatropine.....	23	2.50	0.50	1.12	49	8	32	39	17	22
Homatropine, 5% (1 drop)...	24	1.25	0.50	1.00	30	11	20	35	18	23
Homatropine, 5% (2 drops)..	27	1.50	0.50	0.87	32	13	27	35	14	22
Homatropine, 5% (3 drops)..	19	1.25	0.25	1.00	47	13	29	29	18	21
Paredrine-homatropine.....	22	1.75	0.50	1.25	48	10	26	41	16	23
Homatropine ointment, 2%..	22	3.00	0.50	1.50	48	8	24	41	16	23

THIRD SERIES

The third series was composed of 70 eyes for which a 5 per cent solution of homatropine hydrobromide in varying quantities was employed as the cycloplegic. In 24 of these eyes 1 drop was instilled; in 27, a total of 2 drops, and in 19, a total of 3 drops (1 drop every three minutes). Aside from this, the method of conducting the investigation was the same as with the second series. A composite curve of the average accommodative power, at the intervals indicated, was plotted for each group of eyes comprising the series (chart 3).

Results.—The efficiency of varying amounts of the 5 per cent solution of homatropine hydrobromide is well illustrated in chart 3 and in tables 2, 3 and 4. With 1 drop of the drug the lowest point of depression was reached in one hour and fifteen minutes after the instillation and was 1 diopter; recovery began in one hour and forty-five minutes, and the time of complete recovery was twenty hours.

With 2 drops the lowest point of depression was reached in one hour and thirty minutes and was 0.87 diopter; recovery began in two hours and fifteen minutes, and the time of complete recovery was twenty-seven hours.

With 3 drops the lowest point of depression was reached in one hour and fifteen minutes and was 1 diopter; recovery began in four hours, and the time of complete recovery was twenty-nine hours.

The low point of depression was reached with about equal speed in the three groups. The return of accommodative power began earliest when 1 drop was employed and occurred next in order with 2 and then with 3 drops; complete recovery occurred in the same order. There was not a remarkable difference in the average recovery time, but in those eyes in which only 1 drop of the drug was instilled recovery was seven hours earlier than with 2 drops and nine hours earlier than with 3 drops.

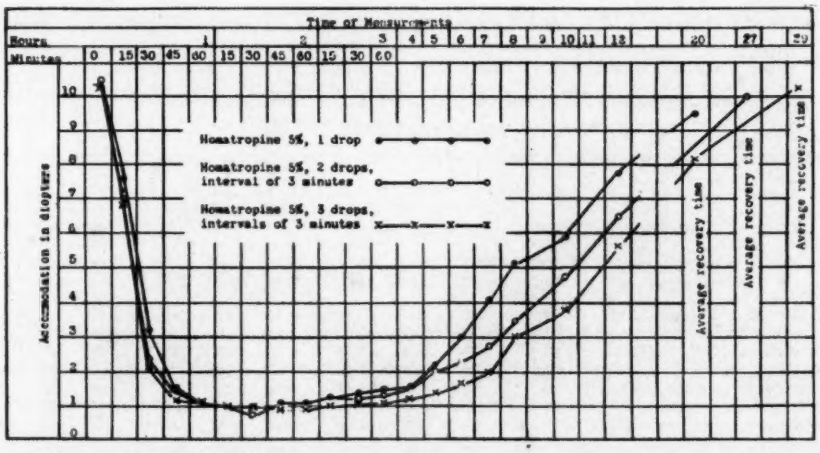


Chart 3.—The depression of accommodation and recovery time following the instillation of 1, 2 and 3 drops of a 5 per cent solution of homatropine hydrobromide. The number of eyes represented are 24, 27 and 19, respectively.

TABLE 3.—*The Limits Between Which the Residual Accommodation Fell in Eyes Investigated in Series 2, 3 and 4*

Cycloplegic	No. of Eyes in Which the Residual Accommodation Fell Between the Limits Indicated				No. of Eyes Represented
	0.50-1.00 Diopter	1.12-1.50 Diopters	1.62-2.00 Diopters	2.12-3.00 Diopters	
Homatropine, 2% (regular)	18	3	1	1	23
Benzedrine-homatropine	12	9	1	1	23
Homatropine, 5% (1 drop)	15	7	2	0	24
Homatropine, 5% (2 drops)	14	9	4	0	27
Homatropine, 5% (3 drops)	13	6	0	0	19
Paredrine-homatropine	10	10	2	0	22
Homatropine (2% ointment)	8	10	3	1	22

It appears from the foregoing data that 1 drop of the 5 per cent solution of homatropine hydrobromide accomplished everything that the 2 and 3 drops did and that the recovery from the effects of the

drug was more rapid. It will be noted from comparison of charts 2 and 3 that 2 drops of homatropine hydrobromide alone depressed accommodation slightly more and that recovery occurred earlier than when benzedrine sulfate was instilled as an adjunct.

FOURTH SERIES

When a second request for a sample of benzedrine sulfate was submitted to the manufacturers of the drug, they sent, instead, a sample of a 1 per cent solution of paredrine hydrobromide which they believed to be just as good or even better than benzedrine. Paredrine was therefore employed in the investigation of the fourth series of eyes.

Twenty-two eyes comprised this series. In 1 eye an ointment containing 2 per cent homatropine hydrobromide was applied in the upper fornix, the application being made with a syringe equipped with a small metal cannula. A good portion of the ointment thus applied was retained more or less successfully. In the other eye a total of 2 drops of a 5 per cent solution of homatropine hydrobromide

TABLE 4.—*Number of Eyes in Which the Complete Recovery of Accommodation Occurred Between the Hours Indicated*

Cycloplegic	Hours					No. of Eyes Represented
	8-12	13-24	25-33	34-52	53-124	
Homatropine, 2% (regular)	10	6	3	4	0	23
Benzedrine-homatropine	6	4	5	8	0	23
Homatropine, 5% (1 drop)	8	11	5	0	0	24
Homatropine, 5% (2 drops)	4	9	8	4	2	27
Homatropine, 5% (3 drops)	0	2	11	6	0	19
Paredrine-homatropine	4	3	13	2	0	22
Homatropine (2% ointment)	5	6	10	1	0	22

with an interval of six minutes between the drops was used, and 1 drop of the 1 per cent solution of paredrine hydrobromide was instilled between the drops of homatropine. The subsequent examinations were made in exactly the same manner as were those in series 2 and 3. The results of these examinations are presented in chart 4 and in tables 2, 3 and 4.

Results.—The curve in chart 4 representing the results with the paredrine-homatropine cycloplegic corresponds closely to that in chart 2 representing the results with the benzedrine-homatropine cycloplegic, except that there is a difference of six hours in the average time of complete recovery of accommodation, that with paredrine and homatropine being the earlier. Accommodation was depressed with the paredrine-homatropine combination with about the same speed as with the other cycloplegics; the lowest point of depression was reached in one hour and fifteen minutes and was 1.25 diopters; recovery began two hours after the instillations were made, and the average time of recovery was twenty-six hours, nearly the same as in the group in which 2 drops of homatropine hydrobromide was used (chart 3).

The ointment containing 2 per cent homatropine was the least satisfactory of all the cycloplegics employed. The lowest point of depression

of accommodation was reached in one hour and fifteen minutes and was 1.50 diopters; recovery began three hours after the application of the ointment, and the time of complete recovery was twenty-four hours. The ointment was not easily introduced into the conjunctival sac, nor was it well retained in a large percentage of eyes; it adhered to the lashes, and this was objectionable, particularly to women. Frequently, when doing the retinoscopic examination, a sheen was found covering the cornea, making the examination extremely difficult.

Benzedrine sulfate in the 1 per cent strength and paredrine hydrobromide in the same strength up to a total of 3 drops (1 drop every three minutes) dilated the pupil an average of 3 mm., and the maximum dilatation occurred in twenty-seven minutes. The same instillations

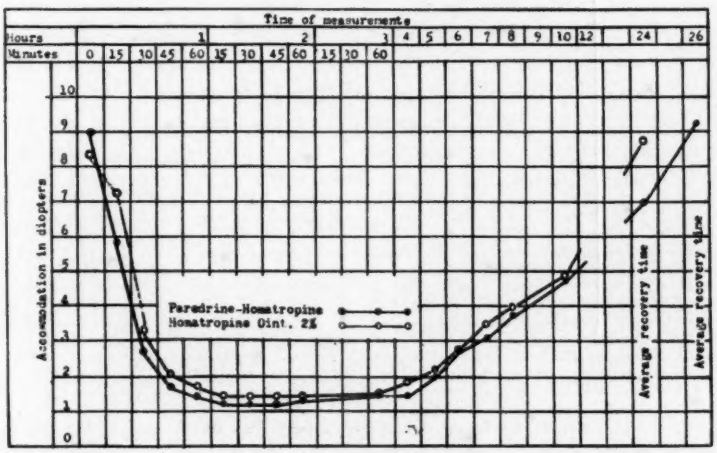


Chart 4.—The depression of accommodation and recovery time following the instillation of the paredrine-homatropine cycloplegic and the application of an ointment containing 2 per cent homatropine hydrobromide. Each curve represents the average accommodation of 22 eyes.

induced an average maximum depression of accommodation of 0.75 diopter in sixty minutes.

CONCLUSIONS

1. Two drops of a 5 per cent solution of homatropine hydrobromide in conjunction with benzedrine sulfate or paredrine hydrobromide; 6 drops of a 2 per cent solution of homatropine hydrobromide, and 1, 2 and 3 drops of the same drug in 5 per cent strength were found to depress accommodation with equal speed and to about the same degree.

2. The period of greatest depression and the time until complete recovery were shorter when 1 drop of a 5 per cent solution of homatropine hydrobromide was employed and instilled with great care.

3. It was found that multiple instillations of homatropine, with or without benzedrine or paredrine, retarded the average recovery time without increasing the speed of onset or the depth of the cycloplegia.

4. It was not demonstrated that benzedrine or paredrine influenced the action of homatropine except that it possibly retarded the time until complete recovery.

5. An ointment containing 2 per cent homatropine was found to be the least satisfactory method of administering homatropine cycloplegic.

6. As a routine procedure, 1 drop of a cycloplegic is a slender staff on which to lean unless the greatest care is observed in its administration. All or a part of 1 drop is easily flicked from the eye, and little effect of the drug will be obtained. At least 2 drops should be instilled, thereby insuring 1 drop for effective action.

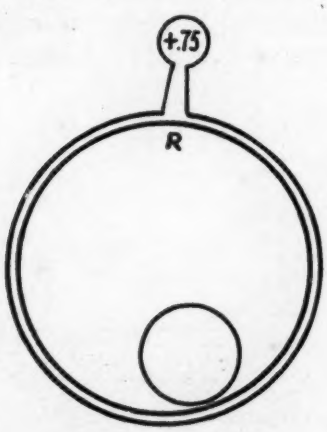
7. Benzedrine and paredrine when administered alone are moderately effective mydriatics and reach their maximum action in twenty-seven minutes. They exert only a slight cycloplegic action, the average depression of accommodation being 0.75 diopter.

Clinical Notes

DEMONSTRATION BIFOCAL LENSES FOR TRIAL CASE

BENJAMIN FRIEDMAN, M.D., NEW YORK

It is frequently expedient to demonstrate the nature of bifocal lenses to a patient who is considering them for the first time. I have found a convenient method in the form of flat bifocal lenses made up to fit the standard trial case rims. The distance base is a plano lens, and the lower segment is a Kryptok circular addition; this type of segment lends itself readily to a flat base. The segment is so placed in the rim that when the



Demonstration bifocal lens for trial case.

handle is upright the reading center is displaced nasally 1.5 mm. The lenses are slipped into the trial frames behind the distance correction, and the patient is instructed to read Jaeger's test type and then to glance around the room. For correction of near vision, additions consisting of a pair of + 0.75, + 1.25 or + 1.75 spheres seem to answer the ordinary requirements. Patients needing additions of more than a + 1.75 sphere have either worn bifocal lenses previously or perhaps had better not consider them at such a late stage in life. At any rate, if stronger additions are desired for reading, one can simply add a little more plus sphere to the distance correction without materially changing the effect of the bifocal lenses. The right and left lenses are distinguished by the letters R and L etched on the glass.

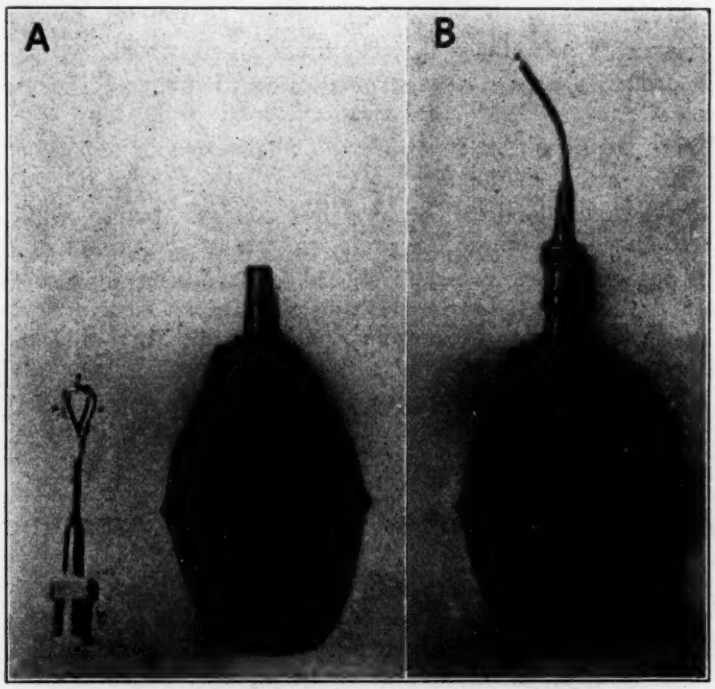
From the Knapp Memorial Eye Hospital.

NEW ANTERIOR CHAMBER IRRIGATOR

DANIEL M. ROLETT, M.D., NEW YORK

Although intracapsular cataract extraction is gaining more and more in popularity, there will always remain a great percentage of cataracts for which this type of operation is not suited. I do not intend to list them, as there are many and all are known to the ophthalmologist.

With such cataracts, especially the traumatic type, it is important to remove as much of the cortical lens masses as possible, as well as remnants of the capsule, to avoid future complications. There are a



Anterior chamber irrigator. *A* shows the two parts of the irrigator, the openings in the loop being indicated by the small dots. *B* shows the assembled irrigator. (Manufactured by V. Mueller & Co., Chicago.)

number of anterior chamber irrigators devised for this purpose; none, however, are free from certain defects, nor is their use entirely devoid of danger. I have therefore constructed a model of a new anterior chamber irrigator which has a number of advantages over the old irrigators and none of the potentially dangerous defects.

My irrigator consists of two freely detachable parts, as seen in *A* of the accompanying illustration. The rubber bulb is made in two sizes. The small size is able to retain about 10 cc. of fluid and the large size approximately 20 cc. The bulb is capped with an attachment

that fits any standard needle. The irrigating needle loop that fits onto the attachment on the syringe, as seen in *B* of the illustration, is really an elongated needle made of silver; the point is curved into a loop which is broad on the top and gracefully tapers to a point below, where it is invisibly fused to the shaft of the needle. It contains three small and not exactly round perforations, one on each side and one at the top. The openings are so graded in size as to direct the jet of fluid emanating from them in the clockwise direction, thereby irrigating the anterior chamber from left to right and forcing the masses present from below, up and to the side and out through the corneolimbic incision.

The pressure on the rubber bulb should be slight and continual, thereby assuring a continued even flow of the irrigating fluid.

The advantages of this new irrigator are as follows:

1. It is easily introduced into the anterior chamber.

2. It produces a gentle, controlled flow of fluid in the clockwise direction.

3. There are no points to injure the cornea, iris or any other structure of the interior of the eye.

4. The flattened loop can be used instead of a spatula, while in the anterior chamber, to replace the prolapsed iris or the pillars of the iris.

5. In post-traumatic cataract, should adhesions be present between the iris and the cornea or the iris and the deeper structures the loop can be used to separate these gently at the same time that irrigation is being done.

6. The silver loop is extremely pliable and soft and can be bent to any desired angle.

POWER OF CYLINDERS IN OBLIQUE MERIDIANS

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It is commonly stated in textbooks and other publications [1] that the power of a cylinder in an oblique meridian is a function of the full power of the cylinder and the angle of obliquity between the axis of the cylinder and the meridian chosen. The relation can be expressed by the equation $C' = C \sin^2 a$, in which C' is the power of the cylinder in the oblique meridian, C the full power of the cylinder and a the angle between the cylinder axis and the oblique meridian. From this equation a table can be constructed showing the "power" in any oblique meridian, as demonstrated in the table in Dr. Olsho's article, page 516.

However, the formula and also the table are only approximations and, strictly speaking, approximations of a special kind. The power of a cylinder is expressed by the power of its meridian at right angles to the axis. In this meridian a section of the cylinder forms a section

1. Olsho, S. L.: Vertical Prism Imbalances in Bifocal Lenses Coexistent with Hyperphoria, Arch. Ophth. **21**:515 (March) 1939.

of a sphere; the circumference is a circle. The power of the cylinder in this meridian is calculated exactly as if it were a sphere with the same radius. But a section of the cylinder in an oblique meridian is no longer a section of a sphere; the circumference forms an ellipse. However, rays striking the lens along this elliptic outline are still refracted according to the full power of the cylinder in its spherical section. For example, a cylindric lens of + 5.00 D. forms a line focus parallel to its axis at 20 cm. If its axis is at 90 degrees, the focal line is vertical. If an oblique meridian is isolated, say, along 60 degrees and light is allowed to pass through this 60 degree meridian, the resultant focus will still be a *vertical line at 20 cm.* The line is shorter and less bright, but its position and direction correspond exactly to the full power of the cylinder, i. e., + 5.00 D.

To be sure, the approximations arrived at by the aforementioned formula are of some use in the calculation of prisms. But it is a mistake, I believe, not to emphasize the peculiar nature of such oblique "power." According to the calculations, the + 5.00 cyl., axis 90 degrees in the example has a "power" of + 1.25 D. at 60 degrees. But this meridian *cannot be neutralized* with a — 1.25 D. as some have tried. Nor will one get a focus at 80 cm. corresponding to + 1.25 D. of power if this meridian is isolated, say, with a stenopaic slit. With these reservations in mind, one will use more intelligently the formula and the table for want of something better.

Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

HISTORY OF THE SURGICAL TREATMENT OF RETINAL SEPARATION

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Ophthalmic literature is inundated with a profusion of approaches, both medical and surgical, for the correction of separation of the retina. This vast number of therapeutic measures was instituted in a rather frantic if not futile series of attempts to treat the disease, about which nothing was known concerning the etiologic or physiologic factors and very little concerning the pathologic process. Each method was essentially empiric, and if a beneficial result followed its use, it was heralded as ideal. If, on the other hand, the outcome was not encouraging, the procedure was soon forgotten, only to be recalled or, more often, discovered years later by a succeeding generation.

Recently, a more exact but still incomplete knowledge of the pathogenicity of retinal separation has been gained. However, the methods now generally used, some of which formerly had been tried empirically, have a more rational basis.

I believe that it might be of interest to present from a historical aspect this vast sequence of attempts, especially of a surgical nature, to alleviate the sufferings caused by the little understood disease which is under consideration. In the following text, therefore, the principal contributions to the treatment of retinal separation will be noted and considered in more or less chronologic order. It is aimed only to review the multiplicity of surgical methods. Medical methods will not be included.

Probably the first anatomic description of retinal separation in the English language was given by Wardrop in 1818; he also presented a plate to confirm his clinical description. B. J. Wood cited Saint Yres in 1722, Morgagni in 1740 and Paniza in 1828 as referring to "hydrops subchoroiditis" and "hydrops choroidal inturnus," both of which are examples of separation of the retina.

Thesis presented to the Faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfilment of the requirements for the degree of Master of Medical Science (M. Sc. [Med.]) for graduate work in ophthalmology.

POSTERIOR SCLEROTOMY

In 1805 Ware practiced posterior sclerotomy for the first time and in so doing was the first to perform a rational operation for the relief of retinal separation. He used "a common spear-pointed couching needle" and described the escape of fluid and the subsequent diminution in tension. Mackenzie in 1830 showed that he was acquainted with the anatomic appearance of retinal separation and recommended the use of a broad extraction knife, which he thrust toward the center of the vitreous, producing loss of blood and vitreous. Burch stated that Mackenzie's description of the surgical treatment of retinal detachment is probably the first one to appear in the English language. This operation was also employed by Sichel Sr. in 1859 and by Kittel in 1860, to whom Uhthoff and later Zentmayer gave priority in performance.

Three years after the invention of the ophthalmoscope by Helmholtz, Coccius in 1853 gave the first accurate description of the fundus picture of this lesion, and in the following year von Graefe published a description which could hardly be improved on even today. Both of these observers saw retinal tears, but it was not until 1867 that de Wecker realized that the tear might be responsible directly for the separation.

According to C. A. Wood, von Graefe as early as 1857 practiced discission of the separated retina. He treated over 50 eyes thus and lost only 1, but only 4 had better vision at the end of a year. The operation consisted in simply passing a narrow knife into the eye behind the ora serrata and then through the retina. In 1863 Bowman performed the double needle operation, somewhat similar to discission in secondary cataract; he attempted to make an opening in the retina so as to establish a permanent communication in the hope that the subretinal fluid would flow into the vitreous chamber. (This is just opposite to the present day attempts.) Hancock in the same year made a sclerotomy opening and cut through the ciliary muscle as well.

First to propose that an irritating fluid be injected into the subretinal space to set up an adhesive choroidoretinitis was Fano in 1866. This procedure he combined with simple scleral puncture. Galezowski in 1872 reported the use of subretinal injections of iodine without success.

Iridectomy has been tried at some time or other for almost all forms of intraocular disease, and separation of the retina is no exception. Fano began this practice in 1869, but after trying it over a period of years he concluded that the only effect was an occasional improvement in vision. In 1872 Galezowski also performed iridectomy, believing the myopia of retinal separation might be analogous to glaucoma. C. A. Wood reported that Castaldi performed iridectomy about six years after these attempts.

RETINAL SUTURES AND TREPHINING

In 1871 Meyer, according to C. A. Wood, "conceived the idea of passing a suture through the retina and drawing it to an opening in the scleral wall." De Wecker and Grizou in 1877 attempted to establish a more permanent form of drainage by passing a curved needle with a fine gold thread through the sclera and choroid and out again and tying the ends over the conjunctiva. Needless to say, the wire produced irritation and the method was soon forgotten.

As mentioned before, retinal tears had been observed, but not until 1867 was their importance recognized, when de Wecker pointed out that the cause of the separation might be the tear itself. C. A. Wood stated that Leber some years later contended that every acute separation recognizable ophthalmoscopically was due directly to a hole in the retina.

The methods providing for permanent drainage continued to increase in diversity. In 1872 de Wecker (cited by Anderson), to whom Meyer Wiener gave precedence for trephining for glaucoma, made a trephine opening over the subretinal space of a separation. Argyll Robertson, generally credited as being first to have trephined the sclera for increased tension, according to Anderson, reported its use in 1876, and then the method fell into disrepute until Elliot perfected his operation.

In 1877 von Kries revived de Wecker's earlier method of sclerotomy and paved the way for Wolfe's operation, reported in 1883. By his method Wolfe lay bare the sclera and made an oblique incision, so that the edges overlapped and permitted drainage of the subretinal fluid. This differed from de Wecker's method and the earlier methods in that the fluid was drained directly and was not permitted to escape under the conjunctiva. Following this method, some surgeons advocated multiple long oblique incisions in the sclera. McKeown (1877) practiced excision of a portion of the sclera, as reported by Zentmayer, and Higgins two years later made a trephine opening through the sclera.

Samuelsohn emphasized in 1875 the value of a compression bandage in an effort to force the retina against the globular wall. Twelve years later, according to Anderson, he admitted that "lasting and complete cures were very rare." Hense in 1879 futilely tried to secure permanency of reattachment by inducing the patient to wear a pressure bandage for the rest of his life.

De Wecker's earlier work with drainage of the subretinal fluid opened the way for Mooren in 1882, who simply aspirated the fluid with an ordinary hypodermic syringe. In the following year Grossman advocated the same method for withdrawal of the postretinal fluid and an injection of a 0.75 per cent saline solution directly into the vitreous with the same syringe. This was to force the retina back mechanically against the choroid by increased intraocular pressure, the same as Samuelsohn had tried to achieve by means of a pressure bandage.

GALVANOPUNCTURE

In 1881 de Wecker introduced galvanopuncture, which soon became the generally accepted method for treatment of retinal separation. The first report, that of de Wecker and Abadie, is given precedence by Anderson, while C. A. Wood stated that de Wecker and Masselon were the first to employ this form of treatment, and Spratt (1935) conceded the priority to Martin, de Wecker and de Luca. De Wecker's method was first to denude and puncture the sclera and then slowly to introduce the white hot electric cautery into the subretinal sac and immediately withdraw it, the idea being to promote adhesive inflammation between the choroid and the replaced retina.

The method of subconjunctival injection was probably introduced by de Wecker in 1887, based on the earlier work of Raehlmann. At first he injected simple salt solution into Tenon's capsule and later added small amounts of gelatin to increase the irritative effect. The solutions used since then have been legion, and as the method of subconjunctival injection is so minor a procedure, it should not be considered as a surgical form of treatment.

As early as 1888 Gaupillar performed superficial cauterization, and Meyer disclosed that Addario in the following year was the first to use thermocautery. These methods were essentially forgotten until they were revived by Gonin some thirty years later.

Schoeler, as shown in his monograph published in 1889, conceived of a shrunken vitreous with traction on the retina as producing separation. Accordingly, after animal experimentation he retried the injection methods practiced twenty years earlier, especially by Fano and by Galezowski. Schoeler introduced various iodine preparations into the posterior chamber, obtaining best results with 2 to 4 drops of tincture of iodine, introduced through a combination knife and cannula of his own invention. Pfluger perfected a syringe controlled by a cogged wheel to allow more accurate introduction of the irritant. C. A. Wood cited a case reported by Gelpke in the same year in which "infective purulent uveitis, meningitis and death" occurred after an injection of 3 drops of tincture of iodine; this caused the procedure to fall into immediate disgrace. Schoeler's work is outstanding, however, if for no other reason than the fact that he was the first to select the retinal tear as the site for operation.

Improving on de Wecker's gold wire drain, Galezowski in 1889 ventured to suture the retina to the sclera and choroid, using a curved needle and catgut. The puncture and counterpuncture were about 15 mm. apart. Failure awaited his attempts, and a needle is said to have broken off within the globe in one of his endeavors. Gonin (1935) cited Martin as having used two silk sutures and Evers a horsehair

suture to attain the same purpose. The inventive Galezowski six years later (1895) tried multiple punctures of the choroid and retina with curved needles, hoping to push or pull the membrane to the globular wall and attach it there by cicatricial points. Pachenstecher in 1894, according to Gonin (1935), used a common steel needle (later a Knapp knife) for multiple punctures and followed this with four additional sclerotomies, the holes being made close together and through the sclera, choroid and retina.

Bull about 1890 revived the work of von Graefe, who more than thirty years earlier had introduced discission of the vitreous. Bull reported good results in 25 of 29 cases in which he used a knife-needle deep in the vitreous. He noted that the operation reduced the danger of extension of the separation and pointed out that it is contraindicated when the vitreous is vascularized because of the likelihood of intraocular hemorrhage.

Spratt (1934) cited Schonfeld's successful results in 25 of 100 cases which he reported in 1892. He used a solution of mercuric and sodium iodide for injection into the subretinal space, employing the same technic as the others before him. Enlarging on this method, Straub (cited by Foster) three years later dissected the conjunctiva, made two parallel incisions in the sclera, closed the conjunctiva and then injected a weak solution of mercuric cyanide and cocaine hydrochloride near the scleral wound.

ELECTROLYSIS

In 1889 Schoeler, who was not encouraged with results obtained by injection of iodine into the evacuated subretinal space, as mentioned previously, began to experiment with electrolysis. He applied a single needle to the subretinal space, and the other he placed over the patient's cheek. The results were not desirable, but, according to Pfingst and Townes, Schoeler's experiment marks the first use of electricity to agglutinate the retina to its bed. Abadie in 1895 reported the use of electrolysis, especially for dispersion of opacities of the vitreous; he used a platinum-iridium needle 8 mm. in length connected to the positive pole of a galvanic battery. The needle was thrust deep into the vitreous body, and a current of 3 or 4 milliamperes was used for five minutes. Terson (cited by C. A. Wood) used the same method but introduced the needle only into the subretinal sac; he considered the procedure superior to and less dangerous than that of Abadie or of Schoeler.

The method of punctiform cauterization of the sclera and episclera tissues was taken up by H. Dor in 1895 (cited by C. A. Wood). He dissected the conjunctiva and applied actual cautery in the form of Guersant's needle. The application was made at a half dozen or more points and was supplemented with injections of saline solution, purges and sweatings. His son, L. Dor, in 1907 combined scleral punctures with

the method, to promote better drainage of the subretinal fluid. Experiments of Scheffels (1894) and Wernicke (1906), as reviewed by Anderson, proved that after such scleral cauterization the three tunics of the globe were definitely adherent if provision had been made for escape of the subretinal fluid, although the retina was completely atrophied.

VITREOUS INJECTIONS

Grossman's previously described method of withdrawal of postretinal fluid and injection of saline solution served as the basis for the classic operations of Deutschmann, described in 1895. He claimed results unattained by any other form of treatment. In order to relieve traction of the vitreous on the retina, he advised bisection of the vitreous, with and without the intravitreous injection of sterile animal vitreous. The operation of bisection consisted in passing a two-edged knife through the conjunctiva and globe, back of the ciliary body, and making a counterpuncture so as to "cut in two" the vitreous chamber. Withdrawal of the knife permitted escape of the subretinal fluid and some preretinal fluid. This maneuver was repeated as often as twenty times. For those eyes with exceptionally low vision, Deutschmann followed the bisection operation by injection near the ora serrata of variously prepared and sterilized concentrations of calf, dog and rabbit vitreous, a special syringe and cannula-knife being used. The operations, of course, are aimed to relieve traction on the retina by the formation of cicatricial adhesions of the vitreous and by increasing the bulk of the vitreous chamber. Deutschmann pronounced cures in about 20 per cent of his cases, but his method was essentially a failure in the hands of others who adopted it.

Jensen in 1892 perfected a workable method for the injection of purified air into the vitreous body to increase its contents and exert pressure on the separated retina, but apparently the results were not encouraging.

Eclampsia and toxemia of pregnancy had been known to be etiologic factors in causing separation of the retina, and spontaneous reattachment in such cases had been reported. Greenwood and Williams in 1902 reported a synopsis of 13 cases and advised "the induction of abortion or premature labor as the most important element in the conduct of these cases."

SCLERAL EXCISION

Based on the belief that separation of the retina, especially in cases of high myopia, is due to the disproportion between the shrunken vitreous humor and the ocular envelops, Müller originated his resection operation and made it known in 1903. The operation involved the exposure of the eyeball by means of Krönlein's approach, division of the

external rectus muscle, excision of a biconvex piece of sclera, tapping of the subretinal space and resuturing of the sclera. When the wound was closed, the whole eyeball was reduced in size. Improvement occurred in a few cases, but according to Török and Heed, in a review of their own results with this operation in 1920, no cures were permanent.

An ingenious method for producing superficial scleral cauterization was devised by Jensen in 1904, according to C. A. Wood. By means of a metal cylinder which he had constructed, he directed small jets of hot steam against the exposed sclera, producing numerous spots of adhesive choroidoretinitis.

Maser in 1905 reported a case in which he passed a Graefe knife through the ocular wall, evacuating the subretinal fluid; he then turned the knife at right angles, making a retinal discission, and withdrew it. His technic differed from that previously described by von Graefe in that he made his dislaceration after puncturing the sac; von Graefe approached the separation from in front of the elevation. The inflammation produced by the knife was exactly what Bowman tried to produce with his two needle operation over forty years earlier.

Continuing the work begun by de Wecker in 1881 with electrocautery, Craig reported a cure in 1905, and Paton in 1908 stated that his patient had full restoration of the visual field. Both of these workers combined sclerotomy with electrocautery.

"COLMATAGE"

Anderson stated that Bettremieux in 1910 performed "nonperforating pericoroneal sclerotomy." This was effected by removing the superficial layers of the sclera round the limbus, over an area 2 by 10 to 18 mm., and covering the wound with a conjunctival flap. The anastomosis thus formed between the deep sclera and the conjunctiva was believed to increase choroidal and retinal venous return from the globe.

Another operation which probably acts in a similar manner was proposed by Lagrange in 1912 and became known as *colmatage*. The procedure consisted in the dissection of a conjunctival flap and the production of a triple row of cautery punctures around and adjacent to the limbus. Lagrange expressed the belief that this would form a cicatricial ring around Schlemm's canal and constrict it sufficiently to raise the intraocular tension and so exert pressure on the retina. Anderson and others have pointed out that hyperemia or chemical changes in the aqueous may also be factors in raising the tension. Many surgeons have used this operation with success and have reported lasting results.

In 1911, according to Arruga (1936), Ohm began to use the method of Jensen, namely, the intravitreous injection of air. The operation

probably was made more popular in the following year by Rohmer. The latter worker opened the conjunctiva at Tenon's capsule and then in another place made a cautery opening in the sclera through which air was injected into the vitreous by a hypodermic syringe. The wound was closed somewhat in layers, the opening in the globe not being directly under that in Tenon's capsule. Injections of air have been used with varied results and will be mentioned again under a later date.

Of historical interest is a case reported in 1913 by E. L. Jones and cited by Cary. The method was that of galvanocautery combined with massive subconjunctival injections of mercuric cyanide. Jones claimed the patient had good vision after twenty-two years.

Thomson and Curtin in 1916 emphasized the fact that to reattach the retina the subretinal fluid had to be evacuated. Accordingly, they used a trephine opening in the sclera, such as de Wecker and Argyll Robertson had instituted forty years previously, but in addition they recommended that ten days after trephining the subretinal fluid should be aspirated and this procedure repeated as often as necessary. Later they advocated aspiration at the time of trephining. Three years later, according to Anderson, Ohm reported two cures with this method.

In 1917 Verhoeff again employed electrolysis, formerly introduced by Schoeler in 1889 and amplified by Abadie, Terson and others as already mentioned. Verhoeff used a large number of small curved needles connected to the negative pole and introduced them into the vitreous through the detached area. The anode he applied to the cheek.

ETIOLOGIC FACTOR

To reiterate, retinal tears had been seen and described by Coccius in 1853 and by von Graefe in 1854. Their importance as a possible etiologic factor in the production of retinal separation was recognized by de Wecker in 1872 (cited by Anderson), but apparently their significance was not appreciated. In 1919 Gonin most adroitly began to emphasize the tear as being the essential factor in causing separation of the retina. He considered the tear to be due to localized adhesions between degenerated vitreous and the retina, which during some form of trauma exert traction on the retina and produce an opening. The liquefied degenerated vitreous then gains entrance to the subretinal "space."

The value of Gonin's theory and his success in treatment with thermocautery was not realized until his results were published eleven years later. This interval constituted a period of surgical indifference in the treatment of separation. The revival of this waning interest will be described later.

CHOROIDIALYSIS

Meller in 1923 described an operation which he called choroidialysis. With this procedure he exposed the sclera as in cyclodialysis, but somewhat farther back from the limbus, and introduced a spatula between the sclera and the choroid (choroidialysis). The spatula, after being carried forward to the equatorial region, was turned so as to perforate the choroid. This permitted permanent drainage of the subretinal fluid, and the hemorrhage was expected to lead to adhesive choroidoretinitis. The fundus presented the appearance of rupture of the choroid. Sloan in 1926 reported 2 cases in which this treatment was used successfully. Coincidentally with Meller's operation, Holth advocated the use of preequatorial sclerotomy to achieve the same result. As described by Anderson, this consisted in the trephining of the sclera anterior to the equator between the external and the inferior rectus muscles and allowed for a communication and permanent drainage between the suprachoroidal space and Tenon's capsule.

After examining an eye that had been cauterized, Handmann in 1923 found adhesions between the sclera and the choroid but fluid still beneath the retina. Thinking that not only the subretinal fluid but the elasticity of the muscularis of retinal vessels were factors in the separation, Sourdille in 1923 was led to use retinal perforation by means of a Graefe knife or cautery together with multiple scleral perforations, already in use. As Meyer pointed out, no account of the presence of tears is made. In 1929 Sourdille modified his technic by the use of galvanocauterization, and in the previous year Birch-Hirschfeld combined the method with scleral excision.

In 1924 Galezowski's attempts with sutures (1889) appealed to Wiener. This surgeon made two trephine openings about 1 mm. apart and with a curved needle passed a horsehair suture from one to the other opening between the retina and the choroid. He reported this form of drainage as successful in 2 cases and as a failure in 5 others.

D. J. Wood in 1920, continuing the efforts of earlier workers who had tried to increase the bulk of the vitreous, injected inter-retinal fluid. Proksch six years later injected mixtures of liquid petrolatum and gelatin. In 1924 Carbone (cited by Anderson) proposed the injection into the anterior chamber of such solutions as gelatin, glycerin and bovine vitreous, with the intention of obstructing filtration and so raising intraocular tension. These methods met with little popularity. A procedure which attained the same purpose, however, was the intravitreous injection of air, and in 1926 Jeandelize and Baudot again revived the method mentioned previously. They injected sterilized air at the periphery of the elevation through numerous scleral punctures and followed this with a subconjunctival injection of mercuric oxycyanide. The use of injections of air was again reported by Arruga as late as 1937.

GONIN'S CONTRIBUTION

The surgical treatment of retinal separation received its greatest impetus from Gonin, who was "to win success when defeat had been all but universally accepted." Vail in 1912 published replies to a circular letter showing that 250 experienced ophthalmologists had never cured an idiopathic separation of the retina, and the startling paucity of successful results figured about 1 case in 1,000. All methods that had been tried were entirely empiric.

As has been mentioned, Gonin in 1919 modestly presented his thesis indicating that the tear was the cause of the separation; that through this the fluid vitreous entered, and that the retina might successfully be reattached by means of thermocautery. Repeated presentations of his cures were unrecognized in 1921 and 1929. In 1929 the importance of his theory and method finally was realized, as Lewis pointed out, only after he drew attention to his work by dedicating it to the memory of his master, Prof. Mark Dufour, at the International Congress of Ophthalmology.

Gonin's method required almost mathematical precision in localization of the tear, at the site of which an incision was made through the sclera, with a knife allowing the subretinal fluid to escape. The edges of the torn retina were immediately sealed with a red hot Paquelin cautery, which was plunged through the incision to a depth of 3 or 4 mm. and allowed to remain for about two seconds. The operation was radical; it produced extensive retinal damage and changes in the vitreous and was applicable only to the preequatorial regions. Nevertheless, Gonin reported that cure was obtained in 73 per cent of 34 cases in which the tear was of less than three weeks' duration, in 48 per cent of 35 cases in which it was of less than three months' duration and in 30 per cent of 31 cases in which it was of more than three months' duration. Such results were unheard of previous to this time.

In 1929 Vogt, after an initial period of skepticism, ardently supported Gonin's theory. He modified the technic by using galvanocautery in place of thermocautery. He also used fine slightly bent electrodes, pointed at the ends so as to penetrate the sclera more easily. With these he frequently made multiple punctures to a depth of 2 or 3 mm., allowing the electrodes to remain for three or four seconds; that is, Vogt kept the cautery point in the globe longer than did Gonin but not as deep. Moreover, Vogt found that he obtained good results when he placed the point as far away as 1 or 2 disk diameters from the hole.

CHEMICAL CAUTERIZATION

The failure of others to duplicate the early achievements of Gonin stimulated research in the use of chemical cauterization for sealing the

retinal tear. Guist in 1929, after experimenting on rabbits with potassium hydroxide, finally perfected a workable method, which consisted in walling off that part of the retina in which the tear is located from the rest of the retina by means of adhesions. This he accomplished by making numerous trephine openings just through the sclera surrounding the tear, touching the exposed choroid in each opening with a stick of potassium hydroxide and immediately neutralizing the effect of the caustic with a 0.5 per cent solution of acetic acid and irrigation with saline solution. The exposed choroid was scratched with a lacrimal dilator to permit the subretinal fluid to escape.

Soon after Guist's paper was published, Lindner worked out practically the same method, modifying the details, and the procedure became known as the Lindner-Guist operation. Lindner continued his modifications and perfected his undermining technic whereby he inserted a probe or repositor through a trephine opening and tunneled between the choroid and the sclera in order to reach the posterior and macular regions. Into these tunnels he injected a mild caustic.

As Gonin's original technic underwent many modifications, so also did that of Lindner and Guist. Typical of these changes were the use of Herbert's punch forceps by Gradle and Meyer (1938) in place of the trephine, and Wright's use of the Green mechanical trephine. The latter worker also used droplets of chromium dioxide of different sizes to give the desired caustic effect, and as Arruga (1936) mentioned, others have used sodium hydroxide, tincture of iodine and phenol. Innumerable surgeons introduced the use of thermocautery and later galvanocautery through the trephine openings.

The Lindner-Guist operation was a great improvement over that of Gonin, but as Peter pointed out in 1934, "each of these surgical procedures is a bit too gross, too traumatic or too tedious in its application." The diversity of technic continued to increase in number, each for the purpose of overcoming the difficulties encountered with the other methods.

SURFACE ELECTROCOAGULATION

In an article published in 1932, Larsson stated that in 1930 he performed his first operation with surface electrocoagulation for the purpose of producing adhesive retinochoroiditis. No accurate localization of the tear was necessary, since he treated the whole quadrant above the separation. The negative electrode was a large plate and the positive electrode a ball about 2 mm. in diameter, while a high frequency current of under 100 milliamperes was used. The sclera was touched with the ball electrode again and again over the area above the tear, contact lasting three to six seconds, until the sclera took on the appearance of parchment. One or two trephine openings were

usually made in the most dependent portion to permit drainage of the subretinal fluid.

Meller modified the Larsson operation by making several scleral trephine openings before applying the active electrode. Yerger pointed out that this often produces a cystic separation even when no separation previously existed but that this later disappears, the rationale of the modification being to produce more widespread adhesions between the retina and the choroid.

DIATHERMY: WEVE'S TECHNIC

In the same year (1930) Weve also employed a small ball as a surface electrode to obtain a generalized coagulating effect (reported in 1932). At the same time he made use of a fine needle in the form of a negative electrode, with which he made multiple micropunctures in the vicinity of the tear, and finally cauterized a larger opening for drainage. In his later report (1936) he abandoned surface diathermy, resorting to the use of needles only, for their perforating diathermic effect and drainage. He judged the duration of the application of the current by the eschar obtained on the scleral surface; usually only a few seconds was sufficient. Weve at first used a straight electrode, but he soon resorted to a curved instrument to obtain better application; in this, many later workers followed his example.

The technic of Weve is not entirely satisfactory, according to Gradle and Meyer (1936), because the needle enters too deeply into the eye and touches the retina, the cautery effect is found only at the tip of the needle and at the point where it enters the sclera and the choroiditic spots produced are so small that it is difficult to get them close enough together to wall off the hole.

An interesting modification of electrocoagulation was suggested by Coppez in 1930 and reported in 1932. On the theory that the diathermic scar, as Knapp related, "depends on the temperature to which the tissue is raised during coagulation, measurement of the temperature should furnish an objective control of the desired result and should be more accurate than any measure of the current employed; furthermore, the effect should always be the same if the same degree of heat is obtained." Coppez accomplished this by the use of a pyrometric electrode. The circuit used by him consisted of two wires of different metals (copper and constantan) soldered at their ends, and a current was generated which varied in intensity, depending on the difference in temperature of the ends of the wires. One soldered end was kept at 0 C. and the other acted as the pyrometric electrode. The degree of heat obtained in the tissues was read on a calibrated galvonometer.

Coppez placed his electrode, a flat disk 2.5 mm. in diameter, on the sclera a number of times for twenty to thirty seconds until a tempera-

ture of 80 C. was recorded by the galvanometer. This he termed "slow coagulation." He did not establish drainage until the end of the operation, at which time he made two incisions with a knife-needle at the most dependent point.

ŠAFÁŘ'S METHOD

Another form of diathermic treatment was worked out by Šafář in 1930 and demonstrated in 1932. The purpose of the operation was to encircle the tear with a wall of exudative choroiditis which would act as a barrier to prevent the spread of the separation. Šafář devised insulated pins, or "nails," of iridioplatinum or stainless steel, 1.5 to 2 mm. long, and also had these combined in groups and in "brushes." These he held in a special pair of forceps. The active electrode consisted of a small ball on a shaft held in an insulated handle. The nails or brushes were applied against the sclera and the forceps touched with the ball electrode, the current enabling the nails to be inserted. Careful localization was done, but no incision was made for drainage, as in most other operations. The nails were inserted so as to form discrete areas or "barriers" of coagulation around the tear, each being left in place until the whole number had been inserted. When these had been removed and the subretinal fluid let out, Šafář often used a larger and very fine needle for making many minute punctures, or "stippling" as he described it, especially in the areas of large disinsertions at the ora serrata. Generally, a current of 30 to 50 milliamperes was employed when one needle was used, and it was increased proportionately when more than one needle was inserted.

Šafář's method, as Marshall (1933) pointed out, had many advantages over other methods. The areas of coagulation could be placed exactly. It was possible to use a more regular current. The areas of coagulation were less likely to be too extensive. Large barrages could be made without losing fluid and the eye becoming soft. It was unnecessary to make a subsequent puncture to drain off subretinal fluid. Furthermore, much could be done by resecting instead of sectioning the muscles. Lastly, Marshall considered the method much safer than puncturing with a knife, a cautery or a trephine.

The use of diathermy in the treatment of retinal separation from this time on became practically universal. This widespread adoption of the principles of Larsson, Weve and Šafář naturally led to many modifications in technic and to the invention of an immense number of new instruments. In both these respects, the name of Arruga is outstanding. This surgeon has written much (1936) on the refinements and the details of the various methods and has contributed a number of useful accessories. Among these may be mentioned Arruga's tiny threaded plugs to close the trephine opening in cases of perforation of

the choroid, lancets for ophthalmoscopic orientation, an adjustable speculum and a retractor for use near the macula. Strampelli devised the diaphanoscope, an instrument for transilluminating and simultaneously cauterizing the tear under ophthalmoscopic control. Likewise to aid in ophthalmoscopic observation during operations, Klein modified the Zeiss contact glass, which other workers had found difficult to use. The list of modifying innovations could be continued to infinity.

Diathermy, as had been mentioned, became the popular method at this period and gave beneficial results in far greater numbers of eyes than had ever been attained previously. In spite of this, a multitude of other approaches continued to appear in evidence.

Rubbrecht in 1933 passed a silk suture through the sclera, choroid and retina in order to obtain a scar and subsequent adhesions. He permitted the suture to remain in place for two days. This method resounds of the treatment of over a half century earlier, but according to Rubbrecht the satisfactory results justified the method.

In 1933 Deutschmann introduced cryocautery by means of solid carbon dioxide applied to the sclera. This procedure also was worked out by Bietti in 1934, who recommended a mixture of carbon dioxide and acetone, which he applied to the sclera with a specially constructed syringe. The effect, of course, was an inflammatory reaction in the choroid.

Meesmann in 1934 again reported the use of pyrometric electrodes and followed the general procedure of Coppez. However, he used a fine pointed pyrometric electrode in a curved quartz tube with a changeable point, so that he could vary the depth of penetration and the size of perforation. Meesmann preferred a temperature of 65 to 75 C., which he obtained in six to eight seconds of application. He also used a blunt electrode for surface coagulation.

WALKER'S NEEDLES

In 1934 Walker improved the Šafář operation by designing a great variety of special iridoplatinum needles or "micropins" and a more delicate special high frequency apparatus; these now are in standard use, especially in the United States. The needles are shorter than those of Šafář and are applied by means of a special electrode and silk thread. This not only prevents their being lost or left in the eye but permits them to be placed close together. The micropins are usually inserted about 2 mm. apart, a current of 25 to 30 milliamperes being used. By this technic holes may be encircled by a barrage of needles much farther back toward the posterior pole with greater ease and with less trauma than by the Šafář method. Walker's apparatus is simple, and the time required for operation is much shorter.

Wheeler in 1934 and also Crisp expressed the idea that the thermophore might be a satisfactory method for treating retinal separation. In 1936 Langdon reported that in 1934 he first used the Shahan thermophore at a temperature of 65 C., making one minute applications to the sclera. This was preceded by sclerotomy for drainage. By 1938 Langdon had performed 5 operations of this type, with poor results in only 1 case.

ELECTROLYSIS

Ever searching for a better method to defeat the perplexing problem of retinal separation, ophthalmologists again tried the irritant effect of electricity. Vogt in 1934 revised the method of Verhoeff, whose efforts in turn had been preceded by Schoeler in 1889 and by Abadie and Terson in 1895, as already mentioned. Imre also advocated electrolysis at about this same time. Vogt used a galvanic current of 0.5 to 1 milliampere and a long, thin steel needle as the cathode, or negative pole. The anode consisted of an electrode in the form of a small ball or plate held in contact with the eye. The needle was introduced through the sclera and choroid and withdrawn rapidly. This procedure produces coagulation in the choroid due to the liberation of anions at the anode, as evidenced by the presence of free hydrogen bubbles. Recent advocates of electrolysis are inclined to use somewhat higher currents; Gradle (1936) uses about 3, and Moore seldom uses less than 5 milliamperes.

The advantages of electrolysis, according to Arruga (1936), are the simplicity of apparatus, easy ophthalmoscopic control of perforations because of the formation of gaseous bubbles, small loss of subretinal fluid during operation and less need for the detachment of muscles. Marshall (1937) pointed out that the needle in electrolysis is effective throughout its whole length, while the active part in a diathermic needle is located only at its base. With electrolysis, therefore, scleritis, choroiditis and retinitis is obtained; diathermy produces inflammation only in the two outer coats. The difference in the appearance of the fundus obtained by these two methods has been described by Spaeth.

Von Szily and Machemer in 1935 (reported in 1936) introduced a bipolar electrolytic instrument, which consisted of an electrode with both poles in the same handle. For surface coagulation the poles were about 1 mm. apart and were used with a current of about 30 milliamperes. To obtain perforation, one point was blunt and the other longer and pointed, and a current of about 200 milliamperes was used.

A return to the use of galvanocautery was made in 1935 by Veil and Dollfus. Their operation became known as the "juxtachoroidal" method, since they encircled the hole with fine galvanocautery points

which just reached to the choroid. The fluid was then drained by introducing the cautery directly into the subretinal space. Firm scars were reported to appear in a short time.

Pascheff, also in 1935, proposed another form of operation applicable especially for separation in the lower portion of the eye. With this method a trephine opening is made on each side of the inferior rectus muscle, and through each of these openings a diathermic needle is introduced for the purpose of rupturing the choroid. The compression action of the muscle aids in the process of drainage. The method is credited with successful results.

ELECTRODIAPHAKE

The electrodiaphake of Julio L. Lacarrère was brought to this country in 1935 by Castroviejo (Arruga, 1936). This instrument consists of an insulated handle, at the end of which is a thin steel or platinum wire sliding within a thin glass tube. The glass tube is beveled and bent so that it may be applied to the sclera. Variation in the length of the wire permits of introduction into the choroid for coagulation, or deeper for drainage. It may be introduced under and between muscles. Since the electrode is not projected until the tube is applied to the sclera, cauterization may be performed even when fluid is present by gently pressing the tube against the surface. An ordinary diathermic current is used.

The facility and ease with which the Lacarrère electrode could be applied to all parts of the globe soon earned great popularity for it. Variations of the instrument were produced by many, among whom may be mentioned Schoenberg (1935), Gradle and Meyers (1938), Unsworth and Larkin (1937) and Cooke (1936). The technic with this type of electrode is based on the Weve operation, except that the hole is isolated completely by a ring of adhesive choroiditis instead of a series of isolated spots. The needle is introduced at an angle of 45 degrees with the intention of forming a linear searing of the sclera and a linear inflammatory reaction in the choroid. The last few punctures are made through the sclera for drainage. The end result is a diathermic puncture with a "water-tight annular barrier" around the hole.

COMBINED METHODS

The present day tendency is away from the use of a single operative technic in the treatment of separation of the retina. More and more surgeons are using a combination of those methods which they feel are most adaptable to the particular case at hand. Diathermy is usually used in the form of the Larsson, Weve and Šafář methods of application or of one of their modifications. In the United States the Walker

apparatus and needles are preferred, and application is often followed by surface coagulation. Arruga (1936) stated that he often follows diathermy by the undermining technic of Lindner when the macula is involved, while Peter (1938) expressed a preference for catholysis. Marshall (1936) used catholysis to supplement diathermy when sealing the tear. Castroviejo (Arruga, 1936), Gradle and Meyer (1938), Shoenberg (1936) and many others expressed a preference for the "short needle" technic wholly or as a supplementary treatment after the use of "heavy diathermy." Arruga (1937) stated that he occasionally resorts to intravitreous injections of air. Countless operations, especially when bullous separations are encountered, are finished up with a well placed sclerotomy or trephine opening.

Retinal separation is a surgical disease. Through research, variation and elaboration of operative technic, the once almost hopeless malady has been transformed into one in which a large number of cures are obtained. It is a disease for which have been conceived numerous and diverse treatments, all of which have passed through a long evolutionary process, beginning with frank empiricism and advancing to the present rational and scientific state.

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Correspondence

ANGIOID STREAKS

To the Editor:—In the ARCHIVES for May and June 1939 (pages 746 and 935) is published a lengthy paper by A. Hagedoorn in which he describes the histologic changes in the eyes removed post mortem from a patient aged 48. "A clinical diagnosis was made of pseudobulbar paralysis; pseudoxanthoma elasticum, with an associated disease of the fundus; essential hypertension; cardiac hypertrophy and dilatation; hematemesis (cause?), and lobar pneumonia." The patient died of lobar pneumonia. It is not stated that necropsy was performed. The writer concludes that angioid streaks are ruptures in the degenerated Bruch's membrane. He states: "The fundi of the eyes of this patient could not be studied thoroughly because of her clinical condition; she died a few hours after the ocular examination. It was not possible to make an accurate drawing or a photograph of the fundi. There was marked degeneration of the circumpapillary and the macular region, but it was only just possible to trace a few streaks or lines, which resembled angioid streaks."

This statement, to say the least, does not provide a satisfactory basis for assuming that angioid streaks existed in this case. Nor is it stated that streaks were seen macroscopically in the enucleated eyes. In 1926 (*Arch. Ophth.* **55**: 125, 1926) with Dr. R. J. Sisson I reported a study of basophilic staining of Bruch's membrane, a condition that I had observed many years previously. In this paper we described and depicted changes in Bruch's membrane essentially identical with those found by Hagedoorn in his case, including rupture of this membrane. In sections of 600 eyes, selected at random, we found basophilic staining of Bruch's membrane in 70 eyes. The ages of the patients in whom it occurred varied from 48 to 100 years. We concluded that "the condition is without pathologic significance and is simply a senile change which usually does not impair the function of the eye."

Since the condition of Bruch's membrane described by Hagedoorn may occur in eyes without angioid streaks in patients over 47 years of age and since he presents no definite evidence that angioid streaks were present in his case, his conclusion as to the nature of these streaks is obviously unjustifiable. Strangely enough, Hagedoorn makes no mention of Verhoeff and Sisson's paper, although the conclusions thereof are referred to in the paper by Verhoeff and Grossman on "Disciform Degeneration of the Macula," with which paper he seems to be otherwise familiar.

F. H. VERHOEFF, M.D., Boston.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

National Society for the Prevention of Blindness.—The annual conference of the National Society for the Prevention of Blindness will be held in New York, Oct. 26-28, 1939. Headquarters for the conference will be the Astor Hotel. The society will be glad to make reservations in advance at this or at other adjacent hotels for anybody planning to participate.

Arrangements will be made for extending the facilities of the society's offices at Rockefeller Center, 50 West Fiftieth Street, to all visitors.

Committee to Conserve Vision.—The Indiana State Medical Association has appointed a committee on conservation of vision. The resolution authorizing the creation of the committee outlines its duties as follows: (1) to encourage ocular hygiene, (2) to disseminate knowledge for the prevention of blindness and the conservation of vision, (3) to acquaint the public and particularly industries and schools concerning proper illumination and other protective measures for the eyes and (4) to help create and advise classes on the conservation of sight.

Oxford Ophthalmological Congress.—The twenty-eighth annual meeting of the Oxford Ophthalmological Congress was held on July 6-8 at Keble College. Percival J. Hay was master and F. A. Anderson honorary secretary and treasurer. On the first day there was a discussion on orthoptic training, which was opened by Mr. T. Keith Lyle and Mr. Frank W. Law. The following papers were presented during the afternoon: "Cinematograph Film Showing Orthoptic Training in Cases of Convergent Concomitant Strabismus," by Miss Margaret Dobson; "Lexer's Operation," by Mr. R. Weedon Butler; "Ocular Filariasis, with a Report of a Case in Which Microfilariae Bancrofti Were Seen in the Anterior Chamber," by Mr. W. H. McMullen; "The Ophthalmic Surgeon's Functional Operative Paresis," by Mr. Basil Graves, and "Number Forms," by Mr. P. G. Doyne.

On July 7 the following program was presented: "The Aqueous, a Secretion," by Dr. J. Douglas Robertson; "How is a Hyphaema or a Hypopyon Resorbed?" by Mr. Thomas Henderson; the Doyne Memorial Lecture, entitled "The Ocular Consequences of Certain Chiasmal Lesions," by Mr. Frederick Arnold Williamson-Noble, F.R.C.S.; "Drusen of the Retina: A Clinical and Pathological Study," by Dr. Bernard Samuels; "The Clinical Application of Vital Staining in Fundus Lesions," by Mr. Arnold Sorsby; "Some Successful Corneal Grafts," by Mr. J. W. Tudor Thomas, and "A New Unobtrusive Occluder," by Mr. F. E. Preston.

On July 8 a discussion on miner's nystagmus was opened by Mr. T. Harrison Butler, of Birmingham, and Sir. Arnold Wilson, M.P., spoke on "Eye Injuries: Workmen's Compensation and Disability Schedules."

International Organization Against Trachoma.—A general assembly of delegates and of all members of the International Organization Against Trachoma was held, at the headquarters of the Royal Society of Medicine, London, England, on April 21, 1939.

It was decided that the president, Dr. MacCallan, 33 Welbeck Street, London, W., and the secretary general, Dr. Wibaut, P. C. Hooftstraat 146, Amsterdam, Netherlands, should remain in office until the next Concilium Ophthalmologicum, when an election will be held for these offices and for members of the council.

Dr. MacCallan was delegated to write a "brochure" on the subject of trachoma, destined for general practitioners in trachomatous countries.

The next scientific meeting of the organization will be held during the next International Ophthalmological Congress at Vienna, Austria, in 1941.

The next meeting of the council of the organization will be held in Paris, France, at the same periods as the meeting of the International Council of Ophthalmology and of the Société française d'ophtalmologie.

International Council of Ophthalmology.—The International Council of Ophthalmology met in London, England, at the headquarters of the Royal Society of Medicine on April 19, 1939. The president announced that the German government had agreed to take over the responsibilities undertaken by the former Austrian government with regard to the next International Ophthalmologic Congress to be held in Vienna, September 1941. Prof. J. Meller, of Vienna, Austria, was nominated president of the next congress. The following themes were chosen for the discussions: "Plastic Operations on the Eyeball" and "The Pathology of Retinal Detachment, Including the Biology and Pathology of the Vitreous Body." It was decided to lay the question of internationalizing the determination of the axes of astigmatism before the next congress.

The next meeting of the council is to be held in Paris, France, in 1940, on the day before the opening of the annual meeting of the Société française d'ophtalmologie.

UNIVERSITY NEWS

McGill University authorities have announced a list of appointments and promotions, all of which go into effect on Sept. 1, 1939. Dr. Hanford McKee was made professor of ophthalmology. The appointment was announced as for a period of five years.

LUDWIG LAQUEUR, M.D.
1839-1909

WALTER R. BETT, M.R.C.S., L.R.C.P.
NEW YORK

On a warm summer's day in 1874 the director of the ophthalmologic clinic at the University of Strasbourg had a strange experience, which to his expert judgment could only be a prodromal attack of glaucoma. Subsequent attacks were so frequent and so annoying that in 1880 he put himself into the dextrous hands of the famed Zurich ophthalmologist Johann Friedrich Horner, who performed a strikingly successful iridectomy. This was before the advent of cocaine as a local anesthetic in ophthalmic surgery, and the patient, who for a time remained incognito, graphically recorded his case history in a paper entitled "Geschichte meiner Glaukomerkrankung," which was published posthumously.[1]

In the centennial year of his birth (July 25, 1839) it is tempting to recall and once again to recite the achievements and the personal story of a man whose name figures so proudly in the history of glaucoma. Born of Jewish parents in Festenberg, Silesia, Ludwig Laqueur, who received the degree of Doctor of Medicine from the University of Berlin in 1860, had the good fortune to serve as assistant to two men of stature: Albrecht von Graefe and Richard Liebreich. After passing the French state examination in 1869, he took up ophthalmologic practice at Lyon, where he lectured at the École préparatoire de médecine. Three years later he was appointed Ausserordentlicher Professor für Ophthalmologie in the University of Strasbourg, holding the full chair from 1877 until 1907.

Being himself a victim of glaucoma, it is not surprising that this disease held a lifelong interest for his original and inquiring mind. The first to draw attention to the influence of physostigmine salicylate on intraocular tension, in 1876 he introduced this drug in the treatment of glaucoma, at the same time pointing out the dangers of using atropine. Several papers from his pen constitute valuable and now classic contributions to the literature of this malady, such as "Ueber eine therapeutische Verwendung des Physostigmins" in 1876 and "Ueber Atropin und Physostigmin und ihre Wirkung auf den intraokularen Druck" in 1877. It is characteristic that his first and last lecture should have been devoted

1. Laqueur, L.: Klin. Monatsbl. f. Augenh. **47**:639-646, 1909.

to the subject of glaucoma. As a lecturer he was popular with the students, who appreciated the delightfully simple and eminently practical nature of his teaching.

Laqueur was a cultured man of much charm of manner and a keen philologist. He suffered from paroxysmal tachycardia, which he attributed to smoking Havana cigars. His complexion was persistently pale (according to his own evidence even strenuous exercise and emotional disturbances failed to flush his cheeks), and he always complained

From Klinische Monatsblätter für Augenheilkunde (47: 639, 1909).

LUDWIG LAQUEUR, M.D.
1839-1909

of having cold hands and feet. In his family history it is interesting to find that his father's mother, who died at the age of 83, spent the last thirty years of her life in utter darkness due to acute bilateral glaucoma. Laqueur, who incidentally was color blind to red and green, died of pneumonia on April 20, 1909.

By a curious coincidence, another distinguished ophthalmologist, who was born in the same year as Laqueur, was also a victim of glaucoma and reported his own case: Émile Javal, of Paris.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Bacteriology and Serology

THE PNEUMOCOCCUS AS A PATHOGENIC AND SAPROPHYTIC AGENT FOR THE EYE. S. SPIRATOS, Arch. d'opht. 1: 589 (July) 1937.

Spiratos reports observations on the pneumococcus in the eye. He found it present in 15 per cent of normal eyes, in 1 per cent of eyes with acute conjunctivitis, in 75 per cent of eyes with hypopyon ulcer and in 50 per cent of eyes with dacryocystitis. Pneumococcus type X occurred in 64 per cent of the normal eyes; types II and III were found in 17 per cent and type I in 1.8 per cent. In eyes affected with acute conjunctivitis type II was more frequent than type III (20 to 12.5 per cent), whereas in eyes with hypopyon ulcer the reverse was true, type III being found in 23.4 per cent and type II in 17 per cent. In eyes with dacryocystitis only type X pneumococci were found. The organisms found in the eye are the same as those found in the mouth. Type II is found more frequently from February to July, whereas type III is more frequent in the later months. Forty-five per cent of the pneumococci isolated were toxic for the white mouse.

S. B. MARLOW.

Biochemistry

COMPARATIVE STUDY OF THE COMPOSITION OF AQUEOUS HUMOR AND BLOOD PLASMA IN MAN AND IN THE DOG. G. E. JAYLE and Y. I. DERRIEN, Arch. d'opht. 1: 1083 (Dec.) 1937.

The authors present the following conclusions as the result of their study: The proportions of sodium chloride and dextrose in the blood plasma and the aqueous, variable from one individual to another in both man and dogs, has the following characteristics: 1. The relation of the dextrose of the aqueous to that of blood plasma is always less than, or at most equal to, 1. The relation of the sodium chloride of the aqueous to that of the blood plasma is always greater than, or at least equal to, 1. In the majority of cases studied the variation in the proportions of the chlorides and dextrose are coupled in such a way that when one is lowered the other is elevated. These observations indicate that Donnan's law is not followed and that vascular permeability seems to be one of the predominating factors in determing the equilibrium between the aqueous and the blood plasma.

S. B. MARLOW.

Color Sense

A STANDARDIZED LANTERN FOR TESTING COLOUR VISION. L. C. MARTIN, Brit. J. Ophth. 23: 1 (Jan.) 1939.

A lantern for testing color vision is described. Colors are shown in pairs. The lantern is adapted to the use of electric light and is standardized by stringent testing. The experiments and considerations

which led to the formulation of the allowance tolerances in the transmission and color coordinate specifications of the filters, the color temperature of the lamps, etc., are discussed. The results of tests on normal and color defective subjects are described.

Illustrations accompany the article.

W. ZENTMAYER.

A FAMILY WITH COLOR-BLINDNESS. A. M. VIANNA, Ann. d'ocul. 175: 901 (Dec.) 1938.

As it is not a common occurrence to encounter a family in which in successive generations there are a number of persons with color blindness, an appreciable number of them being females, it seemed of interest to report the genealogy of the Morgado family of Portugal, in which it is found that consanguinity plays an important role.

The history is given with charts, without which the article does not lend itself to abstracting.

S. H. MCKEE.

Conjunctiva

INCLUSION BLENNORRHEA. A. E. BRALEY, Am. J. Ophth. 21: 1203 (Nov.) 1938.

This study was made to determine the pathologic changes in conjunctival and cervical tissues infected with the virus of inclusion blennorrhea and to localize the virus. The material for study was obtained from 8 infants with inclusion blennorrhea and from the mothers of 6 of the 8. Braley draws these conclusions:

"1. The inclusion bodies of inclusion blennorrhea can be demonstrated in fixed tissue of the conjunctiva and of the cervix.

"2. The type of epithelium containing the bodies is the same in the cervix and the conjunctiva.

"3. The inclusions occur almost exclusively in the large polygonal 'wing' cells just above the basal layer.

"4. Hyperplasia, hypertrophy, and desquamation of the epithelium are the predominant histological changes in the virus-infected tissues.

"5. The subepithelial infiltrate of inflammatory cells is nonspecific.

"6. Disintegration of follicles and scarring do not occur."

W. S. REESE.

STUDIES ON INCLUSION BLENNORRHEA. L. A. JULIANELLE, R. W. HARRISON and A. C. LANGE, Am. J. Ophth. 21: 1230 (Nov.) 1938.

This is the third of a series of studies and has to do with experimental considerations of the etiology of inclusion blennorrhea. The authors give the following summary and conclusions.

"1. The bacteria cultivable by a variety of methods from inclusion blennorrhea are representative of the flora associated with the normal conjunctiva.

"2. The bacteria so derived are non-pathogenic and they are incapable of inducing experimental inclusion blennorrhea in the monkey.

"3. The infectious agent of inclusion blennorrhea passes through Berkefeld V filters and collodion membranes of 0.6 A. P. D.

"4. Such filtrates are bacteriologically sterile and induce experimental infection.

"5. Attempts to cultivate the infectious agent in tissue cultures were not successful.

"6. Such tissue cultures were not infectious for monkeys and they did not contain inclusions.

"7. The interrelationships of the virus and the inclusion are discussed."

W. S. REESE.

SULFANILAMIDE IN GONORRHEAL OPHTHALMIA. M. W. MICHELS, J. Pediat. **13**: 527 (Oct.) 1938.

Michels used sulfanilamide orally in the treatment of 15 patients with proved gonorrheal ophthalmia. Sulfanilamide was given on the approximate dosage basis of 1 grain (0.065 Gm.) per pound of body weight daily combined with equal amounts of sodium bicarbonate. The average period of hospitalization for the 15 patients was 5.8 days. The ages of the patients varied from 5 days to 3 years. Of these, 2 showed corneal involvement; perforation did not result after the administration of sulfanilamide was started: Six of the group showed bilateral involvement. None of the complications attributed to sulfanilamide were observed in these patients. In the two years prior to the use of sulfanilamide 32 similar patients were treated for gonorrheal ophthalmia by the usual methods, and the average period of hospitalization was 28.5 days. Corneal involvement occurred in 2 cases, the condition in 2 progressing to perforation. Eighteen patients had involvement of both eyes. Four other patients treated with injections of sterile milk were hospitalized for an average of 16.5 days; none of these showed corneal involvement.

J. A. M. A.

LUPUS ERYTHEMATOSIS OF THE CONJUNCTIVA. F. I. YOUSEFOVA and S. N. BOGDANOVITCH, Ann. d'ocul. **176**: 27 (Jan.) 1939.

Lupus erythematosis as seen in the chronic form, on the skin of the affected part, shows itself as a dermatitis. This condition is common in Russia. When a mucous membrane only is affected, a biopsy is necessary for diagnosis. Lupus erythematosis of the conjunctiva is rare. In the literature accessible to the authors, only one article could be found which related to the subject.

This report concerns a young adult of 23 years who came to consultation in 1935 for a bilateral ocular condition. The malady had followed an injury to the right eye three years previously after prolonged working in the field in the sun. The palpable swelling of the right eye was followed by an eruption of spots on the cheek and lids accompanied by photophobia and tearing. The following year the left eye became similarly affected. Since that time the patient has been treated with

drops and ointments without relief. On the contrary, the spots as well as the photophobia, tearing and ocular pain increased.

Considerable further detail of the general examination is given, with three photographs. The author believes that lupus erythematosis occurs on the skin and the buccal mucous membrane and also in the conjunctiva. The extraordinary rarity of lupus erythematosis of the conjunctiva is to be explained in part by the fact that the symptoms are not severe enough to complain of or to be brought to the attention of the ophthalmologist or the dermatologist.

S. H. McKee.

Cornea and Sclera

Tuberculous Sclerokeratitis and Hollande Agglutination Reaction. C. Dejean and Miss Serane, Arch. Soc. d. sc. méd. et biol. de Montpellier **19:** 318, 1938.

Sclerokeratitis is frequently associated with latent tuberculosis without apparent visceral lesions. In such cases the seroagglutination test of Hollande is a most useful aid in diagnosis. A positive result indicates the existence of phagocytic activity against the tubercle bacillus. Ten cases are cited in which this test was made and subsequent treatment with a preparation of tuberculin gave successful results.

J. E. Lebensohn.

Krukenberg-Axenfeld's Corneal Spindle. B. Kayser, Klin. Monatsbl. f. Augenh. **100:** 752 (May) 1938.

Kayser refers to 3 cases of Krukenberg's pigmented spindle reported by Sommer (*Klin. Monatsbl. f. Augenh.* **99:** 468 [Oct.] 1937; abstracted, Arch. Ophth. **20:** 1083 [Dec.] 1938) and adds some explanatory notes on his own observations. He points out that he followed a patient with this condition for twenty years, details of his observations being published in 1929, 1932 and 1936 (*Klin. Monatsbl. f. Augenh.* **83:** 332, 1929; **89:** 770, 1932; **96:** 721, 1936; abstracted, Arch. Ophth. **18:** 153 [July] 1937). Typical pigmented corneal spindles developed in the left eye during seventeen years of observation and in the right eye two years later. Death occurred four and one-half years after an extensive scattering of pigment was noted. Before the onset of the spindles Kayser had examined the patient with the slit lamp because of megalocornea. The location and quantity of the pigment varied during the period of observation. The eye was always free from irritation and pain, and refraction and vision remained unchanged. There were no symptoms of general weakness or disease. Histologic examination did not show any pathologic changes, aside from the scattered pigment and the megalocornea; the eye was free from inflammatory or degenerative changes, and there was an absence of glaucomatous diathesis. According to Kayser, his observations are contradictory to the contention of Vannas (as quoted by Sommer) that eyes with extensively scattered pigment are diseased. He also states that presenile lack of vitality does not exist in these healthy and robust persons. The retinal pigment of the iris in their healthy eyes

disintegrates and is transported into the anterior chamber, whence it is eliminated so slowly that glaucoma rarely develops. The results of histologic examination made in a similar case, reported by Hansen in 1923, are cited.

K. L. STOLL.

CLINICAL STUDY OF COMPLETE OPTIC KERATOPLASTY: REPORT OF CASES. R. FRIEDE, Klin. Monatsbl. f. Augenh. **101**: 1 (July) 1938.

After a short historical and technical sketch, the author reports his results with complete, penetrating optic keratoplasty on 78 patients. Usually corneal disks from 3 to 5 mm. in diameter, obtained with a trephine, were transplanted, but in some cases the disks were 6 to 11 mm. in diameter. Friede was assisted by one helper, who was not a physician. From 1921 to 1929 some 18 per cent of the transplants remained clear and 31 per cent became translucent, whereas from 1930 to 1938, 52 per cent of the transplants remained clear and 29 per cent became opaque. One reason for this improvement was the elimination of extensive total leukomas in recent years. Short notes on the histories of 10 patients are presented, followed by detailed discussion of the following subjects: the type of cornea fit for the operation, with special reference to precautions against glaucoma; the removal of adhesions of the iris and extraction of adherent cataracts; the use of subconjunctival injections or paracentesis of the anterior chamber in an attempt to clear the cloudy portion of the cornea, and abscission of the entire leukoma or of the entire cornea. Friede mentions in this connection that dystrophic changes were not noted in the new cornea of one patient. Other topics discussed were: relativity of the vision in both eyes; selection of the type of operation; evaluation of the material gained from the donor, and the preoperative preparation of the donor with reference to his general physical condition. Consideration is given the size of the pupil, the size of the donor's transplant in relation to the size of the opening in the patient's cornea and furthermore as to whether the edges of the transplant should be perpendicular, slanting or step shaped. Paragraphs are devoted to suggestions regarding the size of the transplant and its anchorage and the treatment of the lens. Prolapse of the lens was hardly ever observed after the formation of trephining openings of 3 to 6 mm. in diameter, if the anterior chamber had been preserved. Complications due to abnormal conditions of the vitreous must be expected in most cases, especially in the presence of large leukomas, when the anterior chamber is narrow or abolished. Operative methods after those of Grieshaber, Kuhnt, Elsching, Filatow and others may be resorted to in these cases.

Ectasias of the transplant, produced by sudden changes of intraocular tension, may offer a difficult problem. Closure of the lids by sutures has been useless. Of those transplants in which ectasias occurred, 58 per cent became totally opaque, 14 per cent healed but were translucent and only 28 per cent remained clear. Friede endeavors to overcome the ectasia by increasing the extraocular tension and perfecting the anchorage of the flap during the operation; he points out, however, the difficulty in obtaining results by postoperative procedures in these cases. Reduction of the intraocular tension, either surgically or by

local treatment, is more promising in the presence of ectasias. The author elaborates on the causes of the clouding of the transplants and the possibility of reducing the frequency of this occurrence. The clouding may occur in three stages: soon after the operation, in fact after twenty-four hours; during recovery, while the transplant is healing into the wound, and later, this stage being the least promising for treatment.

The destructive effect of the aqueous humor has been observed repeatedly by the author. He witnessed the clearing of a beginning opacification of a transplant simultaneously with the spontaneous closure of a corneal fistula. In cases in which reexamination was done after a number of years the inner layers of the transplant were usually opaque whenever lasting cloudiness had developed while the external layers had remained clear.

Friede concludes his compendious paper with a summary of the final results. Optic homoplasty seems to be the operation of choice. The number of clear transplants reported appears to be less frequent when the results of so-called torsion-autoplasty are included in the statistics; yet this method promises better results with future improvement of the technic. The author found that transplants taken from cadavers yielded 45 per cent clear healings; those taken from enucleated eyes yielded 25 per cent good results, and those taken from eyeballs with sarcoma yielded 71.5 per cent clear healings and 28.5 per cent opacifications. The results with transplantation of the entire cornea were discouraging. The final result of some successful implantations was impaired by complicating diseases of the retina or choroid or by astigmatism of a high degree.

K. L. STOLL.

Experimental Pathology

TREATMENT OF EXPERIMENTALLY PRODUCED EXOPHTHALMOS WITH THYROXIN AND OTHER IODINE COMPOUNDS. G. K. SMELSER, Am. J. Ophth. **21**: 1208 (Nov.) 1938.

Following experiments on thyroidectomized young adult guinea pigs which were given daily injections of sodium iodide, diiodotyrosine or thyroxin and then (in two thirds of the animals) injections of anterior pituitary extract, Smelser gives the following summary:

"1. Injections of large amounts of sodium iodide produce a slight transitory proptosis and widened palpebral fissure.

"2. Sodium iodide reduced the weight of the orbital content, through its action on the dorsal lacrimal.

"3. Exophthalmos produced by injection of anterior-pituitary extract is unaffected by coincident administration of sodium iodide.

"4. Diiodotyrosine does not affect the orbital content nor the development of anterior-pituitary exophthalmos.

"5. Thyroxin injections produce a marked enophthalmos and ptosis.

"6. The orbital content of thyroxin-injected animals is markedly reduced. All of the tissues are involved in the weight loss.

"7. Thyroxin injections reduced the incidence of anterior pituitary exophthalmos from 86 percent to 52 percent.

"8. Anterior-pituitary extract increased the weight of the retrobulbar tissue of thyroxin-injected animals, though not above that of uninjected controls.

"9. Exophthalmos can be produced in hyperthyroid guinea pigs, but in less degree than in hypothyroid animals.

"10. These experiments substantiate previous evidence of the similarity of experimental anterior-pituitary exophthalmos and clinical progressive exophthalmos."

W. S. REESE.

THE EFFECT OF SECTION OF THE POSTERIOR CILIARY ARTERIES IN THE RABBIT. J. V. V. NICHOLS, Brit. J. Ophth. **22:672** (Nov.) 1938.

In these experiments the technic of Wagenmann was followed as closely as possible. The author gives the following summary:

"1. Wagenmann's experiments, in which he produced a pigmented degeneration of the retina in rabbits by section of the posterior ciliary arteries have been repeated and confirmed.

"2. It has been shown that it is impossible to interfere with the ciliary arteries without injuring the ciliary nerves, but it would seem that one is justified in assuming that the lesions thus produced are the result of a purely vascular disturbance.

"3. It was found impossible to confirm Wagenmann's statement that section of only a few posterior ciliary arteries was necessary to produce these degenerative retinal lesions. Section of at least two thirds of all the arteries was necessary.

"4. The ophthalmoscopic findings following operation were first, an ischaemia of the retina and choroid in the region supplied by the bulk of vessels cut. This was followed by oedema, and the retinal degeneration in the areas where the circulation had not been restored. The pigment formed conglomerate masses and had no relation to the vessels.

"5. Histologically the areas of degeneration showed massive necrosis of all retinal layers starting with the outer layers. At the borders of the regions stages in the process could be seen.

"6. The choroid beneath these areas showed for the most part dilated vessels containing blood.

"7. The histologic appearances taken all together were unlike those of retinitis pigmentosa. Certain areas had a superficial similarity. Detailed examination of the latter showed that there was less gliosis, and a different pigment distribution from what occurs in retinitis pigmentosa. Degeneration of the rods and cones affected their nuclei last of all, and they degenerated equally rapidly.

"8. It is concluded that the results of these experiments do not support the vascular theory of the causation of the retinitis pigmentosa. On the contrary, evidence was found which is against that theory."

The article is illustrated.

W. ZENTMAYER.

General Diseases

THE EYE AND DIABETES: CONTRIBUTIONS BASED ON PERSONAL OBSERVATIONS. G. WEILL, Bull. Soc. d'opht. de Paris **50:** 364 (June) 1938.

Weill presents a study of private patients with diabetes in addition to ocular conditions, seen during the period from January 1922 to December 1937. There were 290 patients in the group, those with diabetes insipidus and infantile diabetes being excluded. Of these, 47, or 16 per cent, had no ocular lesion; 102, or 35 per cent, had incipient changes in the lens, and 140, or 48 per cent, had lesions of the eye not including the lens. Of the last group, 82, or 28 per cent of all the patients with diabetes, had retinitis or papilloretinitis; 16, or 5.5 per cent, had involvement of the uveal tract; 17, or 5.8 per cent, had diplopia; 11, or 3.8 per cent, had glaucoma; 5, or 1.7 per cent, had retrobulbar neuritis; 5 had hemianopia; 2, or 0.69 per cent, had herpes zoster ophthalmicus and 2 had hemorrhage in the vitreous.

Of the 82 patients with retinopathy, 60, or 72 per cent, had albumin and general arterial hypertension above 150 mm. of mercury. Of the 135 patients having albumin and general hypertension, 37 per cent did not have retinopathy. Cataract is more frequent in diabetic persons. It is present in from 15 to 35 per cent of cases.

L. L. MAYER.

OPHTHALMOSCOPIC OBSERVATION OF ALTERATIONS OF THE RETINAL VESSELS IN CASES OF DIABETES COMPLICATED BY ARTERIAL HYPERTENSION. P. BONNET and G. BONAMOUR, Bull. Soc. d'opht. de Paris **50:** 367 (June) 1938.

In times past alterations of the blood vessels of the retina in cases of diabetes were considered rare. In 1915 Leber expressed the opinion that such alterations were a contributing factor to the condition. Eduard Grafe and Volhard considered the vascular alterations related to arterial hypertension as fundamental in the retinal changes of diabetes. The authors call attention to alterations of the retinal veins, visible with the ophthalmoscope, in diabetic patients with general hypertension. Beauvieux and Pesme were the first to show the predominance of alterations at the level of the veins and capillaries. They observed sclerosis with hyaline degeneration of the walls of the veins. They have shown that the retinal hemorrhages consist of accumulated red globules without plasma, serum or deposits of plasma.

The vital phenomenon observed by the authors is that the walls of the veins allow a transudate of blood. Three cases are reported to emphasize this phenomenon. The authors believe that the alteration which they observed in the veins is responsible for the frequent preretinal hemorrhage and proliferating retinitis found in diabetic patients.

L. L. MAYER.

EXPERIMENTAL AND CLINICAL STUDIES ON DENTOGENIC FOCAL INFECTION. P. CHOJNACKI, Arch. f. Ophth. **139:** 288 (Sept.) 1938.

The author studied bacteriologically the devitalized teeth of 10 patients with iritis and 4 with retrobulbar neuritis by the following

method: The suspicious teeth were extracted, and their roots were broken off and shaken in test tubes containing saline solution for thirty minutes. The resulting suspension was transferred to Rosenow's medium (beef broth with calf brain). Twenty-four hours later doses of from 2 to 10 cc. of the primary culture were injected intravenously into rabbits. The animals were observed clinically for five days and then killed. Material from their eyes, livers, kidneys, lungs, hearts and some of their joints was cultured on Rosenow's medium.

The results were compatible with Rosenow's theory of elective localization. In most of the cases in which the organisms grown from a dental focus electively affected the eye of the rabbit, the original ocular disease seemed to respond favorably to the removal of the tooth. The author's view that nonvital teeth without apical granulomas are more dangerous than teeth with granulomas is not supported by experimental or clinical evidence. He states that if one nonvital tooth in the mouth of a patient with iritis or retrobulbar neuritis proves to be infected, all nonvital teeth should be extracted; otherwise no success can be expected. He also states that negative roentgenographic findings do not exclude the possibility of infection.

P. C. KRONFELD.

Glaucoma

ANTERIOR HEMORRHAGIC GLAUCOMA (CONTINO). G. FAVALORO, Klin. Monatsbl. f. Augenh. **100**: 745 (May) 1938.

Contino and Favaloro described for the first time a type of glaucoma of a distinct clinical character. It is always irritative and painful, takes a subacute course and is characterized by ciliary venous or arterial hyperemia. In addition, edematous opacities of the cornea, a deep anterior chamber and an enlarged pupil, with or without spontaneous or postoperative hemorrhages of the iris, are observed. Newly formed blood vessels are noted on the surface of the iris; the intraocular tension is raised. The disease is unilateral, at least in the beginning, and terminates with blindness. Contino inaugurated the term "glaucoma anterius hemorrhagicum." Favaloro distinguishes the following clinical types: (1) irritative glaucoma without new formation of blood vessels on the iris (apparently occurring mainly in young patients); (2) irritative glaucoma with newly formed veins on the iris (accompanied by vicarious hemorrhages and occurring in patients of advanced age); (3) glaucoma anterius hemorrhagicum with newly formed veins on the iris and hemorrhages in the iris or the retina or genuine angiopathic hemorrhagic glaucoma; (4) glaucoma anterius hemorrhagicum with precipitates on Descemet's membrane, or genuine angiopathic inflammatory glaucoma; (5) hemorrhagic glaucoma without vascularization on the iris; and (6) posthemorrhagic glaucoma, or ophthalmic angiopathy with secondary increase of the intraocular tension. The last type follows thrombosis of the central vein; it is the typical hemorrhagic glaucoma. The etiologic and pathogenic factors are arteriosclerosis, syphilis, tuberculosis, disturbances of the metabolism or of the neurovegetative system and disturbances connected with the menopause.

For the first type, surgical treatment was necessary, and pilocarpine was used in 2 cases of the second type. For all other types of glaucoma

anterius hemorrhagicum, mydriatics were recommended, because of their action on the iris and the ciliary body in decreasing congestion.

K. L. STOLL.

Injuries

BILATERAL OCULAR CHANGES IN FRACTURE OF THE SKULL: REPORT OF A CASE. R. TERTSCH, Klin. Monatsbl. f. Augenh. **100:** 857 (June) 1938.

A boy, aged 16, fell from a wagon on his face and suffered a fracture of the mandible and infractions at the cranium and the base of the skull, followed by unconsciousness, hemorrhages from the nose and ears and subconjunctival and palpebral hemorrhages. Roentgenograms showed no fracture in either optic canal. The motion of the eyes was absent for several days after the accident. The pupils were wide and rigid; perception of light was lacking, and extensive retinal hemorrhages were noted. No pathologic cerebral symptoms were observed. The retinal hemorrhages were caused by venous thrombosis; this symptom, the descending atrophy of the optic nerves and the pupillary disturbances suggested the presence of hematoma of the sheaths of the optic nerves. The blood may have originated from the anterior cavity of the cranium. Illustrations demonstrate bilateral vesicular detachment of the membrana limitans of the vitreous in the area of the disks, coupled with retinal hemorrhages and degenerations, such as are observed in connection with injuries to the skull. Only 2/50 of the normal vision was regained in the right eye and perception of hand movements in the left eye.

K. L. STOLL.

Methods of Examination

OPHTHALMOSCOPY BY FOCAL AND INDIRECT ILLUMINATION. A. ZAMENHOF, Arch. d'opht. **1:** 481 (June) 1937.

The author points out that while focal and indirect illumination are in everyday use for the examination of the anterior segment of the eye such methods are neglected in the examination of the fundus. He describes the advantages to be obtained by direct or focal illumination with red free light of the mirror surfaces of the retina. He points out that many details can be discovered by indirect illumination which may be deep or superficial. He presents some optical considerations and the description of an apparatus to attain these ends. He then goes into some detail in describing conditions which are to be found in the vitreous, the retina and the choroid by the use of these methods. He points out that it is not necessary to have an apparatus for the purpose, as one can simply adjust the diaphragm on an electrical ophthalmoscope so that an image of the filament is formed on the retina. Just as the biomicroscope has revealed unsuspected conditions in the anterior segment, so the ophthalmoscope brings out changes in the retina. The author feels that the use of the biomicroscope and the contact glass for the examination of the fundus is unnecessarily complicated. The illustrations and discussion depict clearly the points that he tries to make.

S. B. MARLOW.

VALUE OF INDIRECT ILLUMINATION IN THE SEARCH FOR FINE DEPOSITS ON DESCEMET'S MEMBRANE. F. TERRIEN, Arch. d'opht. **1:** 501 (June) 1937.

This article is prompted by the reading of Zamenhof's paper on the value of indirect illumination in examining the fundus. Terrien thinks that this is a neglected simple method of examination and believes that by its use changes can be found which would otherwise escape attention. It has the advantage of great simplicity. It consists in the use of the transilluminator close to the cornea to illuminate the cornea itself. The examination can be carried out by enclosing a small ophthalmoscope lamp in a tube of rubber or of some other substance which leaves only the extremity of the lamp uncovered.

S. B. MARLOW.

Neurology

OCULAR FINDINGS IN ESSENTIAL EPILEPSY, WITH ESPECIAL REFERENCE TO VASCULAR SPASM. M. MECCA, Ann. di ottal. e clin. ocul. **66:** 457 (June) 1938.

The literature on the ocular findings in essential epilepsy with especial reference to vascular spasm is reviewed. This shows some difference of opinion. The majority of observers, however, observed phenomena of ischemia and vascular spasm during the attack of epilepsy. The author observed a child of 9 years immediately after a severe attack, followed by unconsciousness for several hours. The next day almost complete bilateral blindness was present, only intense light being perceived with either eye. On the second day, when the patient was seen by the author, vision was still limited to perception of light. The posterior part of each fundus was milky white; the arteries were thin, but without complete interruption of the blood column; the disks were pale with indistinct outlines, and the veins were full. A red spot surrounded by a gray ring was present in both maculas. Under treatment with acetylcholine, the edema absorbed and vision improved to 1/4 in the right eye and 1/10 in the left eye, although the arteries remained small. Several attacks occurred during the period of observation, but without apparent effect on the ocular findings. After several previous attacks, the patient had complained of temporary diminution of vision. Since no source of emboli could be found, the author concludes that the ocular findings in his case can be explained on the basis of bilateral spasm of the central retinal arteries during an attack in which the cerebral vessels were presumably similarly affected.

A bibliography is included.

S. R. GIFFORD.

A CONTRIBUTION TO THE STUDY OF ARACHNOIDITIS OF THE OPTIC CHIASMA. A. RUBINO, Riv. oto-neuro-oftal. **14:** 552 (Nov.-Dec.) 1937.

Rubino describes 5 cases of arachnoiditis of the optic chiasma, in 2 of which operation was performed. In the first case there was an irregular inferior hemaniopia with constriction of the remaining field and vision of 1.0 in each eye. Each nerve head showed early primary

atrophy. In the second case there were generalized constriction of both fields, especially on the temporal sides, and a temporal hemianopia for red and blue in the left eye. Vision was reduced to 4/50 and 1/10. Ophthalmoscopically, there was an atrophic pallor of the disk with a haziness of the margins. In the third case there were marked reduction of vision and a homolateral inferior relative central scotoma associated with an absolute scotoma. Ophthalmoscopically, there was pallor of the disk limited to the temporal half. In the fourth case all the symptoms usually associated with a chiasmic syndrome were present; this necessitated a differentiation between parasellar tumors, meningioma of the sella turcica and arachnoiditis. Careful examinations, general and roentgen, and lumbar taps ruled out the two previous conditions. In the fifth case there were central scotoma and temporal atrophic pallor. These symptoms led to a discussion of the differential diagnosis of retrobulbar neuritis and multiple sclerosis. Operative intervention is indicated: (1) when the visual acuity drops rapidly, (2) when the visual fields become constricted progressively, (3) when there are marked changes in the fundus, (4) when iodide treatment has been proved ineffective and, finally (5) when all things point without question to a mechanical process of arachnoiditis.

F. P. GUIDA.

Orbit, Eyeball and Accessory Sinuses

CHOLESTERINOSIS BULBI. P. M. GEORGARIOU, Arch. f. Ophth. **139:** 32 (Aug.) 1938.

The left eye of a 14 year old girl had sustained an apparently blunt injury ten years previously. At the time of the clinical examination it was inflamed, soft and blind; the iris was atrophic and hyperemic, and the lens was cataractous. The lower half of the anterior chamber was filled with a solid-looking white mass, whereas in the upper half innumerable needle-shaped crystals were floating about. The anterior chamber was emptied by keratome incision; the white mass and the floating crystals proved to be cholesterol. One day after paracentesis the anterior chamber was again found to be partly filled with crystals. The author calls this rare condition cholesterinosis bulbi. He considers it to be essentially different from the various forms of lipoidosis bulbi and speculates as to its pathogenesis.

P. C. KRONFELD.

Physiology

THE PRESSURE IN THE INTRAOCULAR BLOOD VESSELS. K. ASCHER, Arch. f. Ophth. **139:** 62 (Aug.) 1938.

The author's extensive dynamometric work has been done chiefly with an original instrument of Bailliart (made by Boulitte, Paris) and with the instrument devised by Sobański. Ascher considers the determination of the pressure in the retinal veins difficult and that of the systolic pressure in the arteries "occasionally dangerous"; he has, therefore, confined himself to determining the diastolic pressure in the retinal arteries, using as a criterion the appearance of the first clearly visible pulsations. Ascher reports that rapid lowering of the atmospheric pressure in a pressure chamber lowers the diastolic pressure in the retinal

arteries without altering the intraocular pressure. In space-occupying intracranial diseases the diastolic retinal pressure is usually found to be high. In such instances the determination of the retinal vascular pressure is of great diagnostic significance. Ascher has also studied 51 cases of tabes and has been unable to confirm the findings of Lauber and Sobański of the existence of an unfavorable ratio between intraocular pressure and diastolic retinal pressure in the cases of atrophy of the optic nerve. He, nevertheless, considers the theoretic views of tnese authors with regard to the mechanism of tabetic atrophy of the optic nerve as "heuristically valuable."

P. C. KRONFELD.

Retina and Optic Nerve

THE HISTOPATHOLOGY OF PAPILLEDEMA. B. SAMUELS, Am. J. Ophth. 21: 1242 (Nov.) 1938.

Samuels reports the findings in 50 globes, all removed after death and assembled under the diagnosis of papilledema. He discusses the histologic picture in these globes and makes the following comment:

"1. A papilla seen clinically with moderate increase in elevation and circumference would probably show under the microscope the neuroepithelial layers of the retina to be compressed. In the atrophic stage one should expect little or no change in the pigmentation at the border, so that such a nerve head could not be differentiated clinically or pathologically from primary atrophy.

"2. A papilla in which the swelling is clinically high on the nasal side and relatively low on the temporal side anatomically would be apt to show displacement of the neuroepithelium on the former, and compression on the latter side.

"3. Those cases in which the elevation of the papilla is very great and the borders steep clinically would correspond to those seen pathologically with a large circumpapillary space filled with the characteristic tissue already described.

"4. A marked dilatation of the retinal blood vessels may be taken as a sign of constriction in the capillaries caused by folds in the deeper layers.

"5. In cases in which an enlarged blind spot is not to be accounted for by the breadth of the papilla, the existence of a slitlike detachment of the retina should be suspected. Over such a detachment the retina was usually found in the specimens to be but little folded.

"6. When the edema is very great, what we see is not all optic nerve, but much of it is a broad zone of cystic retina and circumpapillary tissue.

"7. In the stage of complete atrophy one should not expect to see with the ophthalmoscope any vestige of circumpapillary tissue, for this disappears along with the nerve fibers.

"8. A disturbance of pigmentation is to be looked for clinically, on the nasal side, either at the immediate margin of the disc or at a considerable distance away. These are the only permanent tracks left by the circumpapillary tissue.

"9. Routine examination study should be made of the macular region for evidence of cystic degeneration in cases of papilledema."

W. S. REESE.

A NEW TECHNIQUE FOR THE APPLICATION OF RADON SEEDS TO THE SCLERA IN THE TREATMENT OF GLIOMA RETINAE. H. B. STALLARD, Brit. J. Ophth. **22:** 604 (Oct.) 1938.

According to Stallard, "this paper describes a method of applying radon seeds to the posterior part of the sclera by means of embedding the seed or seeds in a strip of Stent dental wax moulded to the sclera at the desired site. The Stent strip is secured in place by sutures traversing the superficial layers of the sclera in front of and behind the equator."

Before attempting this procedure, the operator should study the technic and illustrations in the original.

W. ZENTMAYER.

RECENT AND PARTIAL IDIOPATHIC DETACHMENT OF THE RETINA. A. MAGITOT, Ann. d'ocul. **174:** 797 (Nov.) 1938.

In spite of the fact that primary or idiopathic detachment of the retina has given rise to much study during the last twelve years. the condition remains one of the most mysterious in ophthalmology. While much has been written about it, the reports have been chiefly with reference to therapy by ignipuncture, first demonstrated by Gonin. Research concerning the etiology has been less extensive, and the theories of more than fifty years still exist, the adherents of each one claiming to be able to solve the problem of pathogenesis.

Attention is called to the excellent report of Arruga at the International Congress of 1934 and also that of Redslob, which appeared in a former issue of the *Annales d'oculistique*.

The case reported in this article concerns a partial primary detachment, in which anatomic examination was made twenty days after the first symptoms and the day after examination of the visual field. The patient was a woman aged 35, in good health and not myopic and with no history of trauma. The case is described in great detail.

The author believes the condition to which the term "idiopathic" has been given to be a syndrome. Research has been difficult because of the rarity of the condition, and it is also only possible to study the genesis on globes which have not been treated.

Twelve illustrations and a bibliography accompany the article.

S. H. MCKEE.

REDUCTION OF ALBUMINOID MATERIAL IN THE DETACHED RETINA: CONTRIBUTION TO THE STUDY OF AMINES IN THE OCULAR GLOBE. H. J. M. WEVE and F. P. FISCHER, Ann. d'ocul. **175:** 823 (Nov.) 1938.

In a former article the authors demonstrated the existence of proteolytic ferments in the subretinal fluid in cases of detachment; later they showed that the modification of tissue metabolism, which is characteristic of detachment, tends to the reduction of albuminoid material.

The authors describe their technic and the amines of the subretinal fluid and ocular tissues. They conclude that the subretinal fluid contains not only ammonia but an equal amount of amines derived from the retina or the choroid.

They state that they can only conclude that in the detached retina there is a reduction of albuminoid material and that as they have not proved that the consumption of oxygen corresponds to combustion of protides, they must interpret the process as a proteolysis. The proteolysis appears to be associated with anatomic lesions of the retina, particularly with tears. The toxicity of the subretinal fluid seems to be due to the appearance of substances following a change in its metabolism. Glycolysis occurs much more frequently in the normal retina than oxidation and causes neither lessening of the albumins nor proteolysis. It has also been shown that detachment, even when curable, profoundly alters the vital processes of the retina. The physiologic and chemical studies show the need of clinical observation. The combination of clinical and scientific research gives the complete picture of the detachment.

S. H. McKee.

THE PATHOGENESIS OF THE NONMYOPIC RETINAL DETACHMENTS (RIGID DETACHMENT, RETINAL CYSTS AND RETINAL SPLITS). O. KURZ, Arch. f. Ophth. **139:** 326 (Sept.) 1938.

According to the author, the mechanism of retinal detachment with tears is, in principle, understood, whereas that of detachment without tears or with disinsertions needs further investigation. The author first introduces the term rigid (*starr*) detachment for a clinical picture with the following characteristics: The detached retina is almost immobile (nonfloating) and free of folds and remains transparent for an unusually long time. The detachment is not noticed subjectively until the macula becomes involved. One often finds ophthalmoscopic signs of spontaneous demarcation (striae retinales). The detachment may be flat or balloon shaped and is usually situated in the lower half of the fundus. Tears, if present, are usually of the disinsertion type. Rigid detachment may be caused by a tumor of the choroid. Detachment in the lower half of the fundus, which is the residue of a primary but latent detachment with tears in the upper half, often resembles the true rigid type. The author reports 11 cases of rigid detachment in which the separation in all probability was caused by blunt trauma. Disinsertions were present in 10 of these cases. Ten patients were subjected to surgical treatment, with reattachment in 7. Rigid detachment was also present in another group of 7 patients in whom, with a single exception, there were no tears but marked "exudative changes" either in the eye (choroiditis) or elsewhere in the body (tuberculosis, organic or functional vascular disease or allergy). In 2 of these 7 patients the detachment was complicated by secondary glaucoma. In this group the results of surgical treatment were also good (reattachments in 5 instances and failures in 2). According to Kurz, vascular disease leads to detachment by making the walls of the vessels abnormally permeable with consequent transudation into and behind the retina or by producing vascular obstruction with consequent degeneration of tissue and the

formation of tears. In a third group, comprising 11 cases of rigid detachment with disinsertions or round holes in the neighborhood of the ora serrata, the causation could not be determined with certainty. The possibility of traumatic origin could be ruled out; there were no exudative changes or signs of retinal cysts. The author observed several cases of true retinal cysts with detachment. In 1 case in which there were several preequatorial cysts some retinal vessels were situated in the anterior walls of the cysts and some in the posterior walls. Little is known in regard to the etiology and pathogenesis of retinal cysts, but congenital anomalies, trauma, inflammation ("exudation") and "physiologic" cystoid degeneration must be considered as possibilities.

By disappearance of the lateral (radial in reference to the eye) walls of the physiologic cystoid spaces, the retina may be split in two layers, one of which may undergo tear formation while the other remains intact (Schichtloch layer hole [Vogt]). Usually the outer (external) layer ruptures first because it does not contain blood vessels. The author reports 2 cases of such partial tears and illustrates his description with instructive drawings of the fundi.

P. C. KRONFELD.

Trachoma

THE FIRST PHASES OF THE DEVELOPMENT OF TRACHOMATOUS PANNUS STUDIED WITH THE BIOMICROSCOPE AND IN HISTOLOGIC SECTIONS. A. BUSACCA, Arch. d'opht. **1:** 308 (April); 402 (May); 505 (June) 1937.

An extensive study of trachomatous pannus was carried out by means of histologic examination of small pieces of excised conjunctiva, and the observations were correlated with those made on biomicroscopic examination. The article contains numerous drawings and photomicrographs illustrative of the points made by the author. The paper cannot be abstracted in such a way as to do it justice. It must be read and studied in conjunction with the illustrations. In summing up his observations the author discusses them under various headings. Biomicroscopic examination of the bulbar conjunctiva shows little involvement, but histologic study shows that the trachomatous infection from its beginning is localized not only in the region of the fornix but in the bulbar conjunctiva. Some infiltration is discovered at the limbus, and, according to the observations made by the author, the earliest true nodules appear in the zone of the terminal vessels; their presence is characteristic of trachoma. Even in a clear cornea there seem to be demonstrated intraepithelial and subepithelial foci. From a general point of view, the formation of pannus is considered a defense mechanism.

S. B. MARLOW.

Therapeutics

IDIOSYNCRASY TO QUININE AND MALARIAL THERAPY OF TABETIC CONDITIONS. E. RAVERDINO, Riv. oto-neuro-oftal. **14:** 537 (Nov.-Dec.) 1937.

Atrophy of the optic nerve following quinine poisoning may present in cases of severe involvement a clinical picture similar to that of tabetic

atrophy. Idiosyncrasy to quinine may give rise to symptoms equal to those of true poisoning. Therefore, before starting malarial therapy, or, better yet, before any antisyphilitic therapy is carried out for persons with tabes, it is important to make a complete ocular examination. In the clinical case reported, because examination had been carried out before the institution of malarial therapy, Raverdino was able to ascertain that he was not dealing with tabetic atrophy but with atrophy due to quinine poisoning. Cessation of the medication allowed vision to return to normal.

F. P. GUIDA.

TREATMENT OF SUPERFICIAL CARCINOMA OF THE LIDS WITH GRENZ (BORDER) RAYS. M. M. BALTIN and Z. M. SEREBRYANY, Vestnik oftal. 11: 677, 1937.

Carcinoma of the lids as recorded in the literature occurs in about 12 per cent of all cancers of the skin. The authors discuss the pros and cons of radical surgical therapy, radium and border ray therapy. The technic of the applied therapy is given in detail. In order to attain an effect on the deeper layers of the tumor, they chose a harder beam of border rays. The basic mass of the rays is absorbed by the epidermis and skin of the lid; thus the deeper sound tissues received a very small dose.

Fifteen patients with carcinoma of the lids were treated. Four received one massive dose, and 11 were given fractional doses.

The conclusions are as follows:

1. In 15 cases of cancer of the lids (basal cell, spinocellular and mixed forms) treatment with border rays gave immediate good results. The time of observation was about two years.

2. Treatment with fractional doses of these rays gave immediate good results. The time of irradiation was from fifteen to twenty days. The disappearance of the tumor and healing occurred at from five to seven weeks.

3. Irradiation with massive doses (5,000 roentgens for a seance) prolongs the time of treatment. In 1 case in which the tarsus was involved a recurrence was observed.

4. An immediate good result was obtained in 2 cases in which the previous treatment with radium gave no effect.

5. No reaction on the part of the conjunctiva, cornea and lens was apparent.

6. The cosmetic appearance and the functional result were good as compared with other forms of radiation therapy; permanent loss of lashes was observed at the site of irradiation.

7. This method of therapy is simple and inexpensive, and the dosage is easily controlled.

8. Further observation will show whether for the eye these safe border rays are superior to radiotherapy, with its exact dosage and correct method of application.

A detailed table and six photographs illustrate the perfect cosmetic result.

O. SITCHEVSKA.

Society Transactions

EDITED BY W. L. BENEDICT

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

JAMES W. WHITE, M.D., *Chairman*

March 20, 1939

RUDOLF W. AEBLI, M.D., *Secretary*

ASPIRATION OF THE ANTERIOR CHAMBER FOR GLAUCOMA AND OTHER DISEASES OF THE EYE. DR. CONRAD BERENS and DR. JOHN S. CREGAR, EAST ORANGE, N. J.

Aspiration of the anterior chamber is a simple procedure which may be performed without shock to the patient, little pain and no complications. It is especially of value in the treatment of chronic simple glaucoma and of secondary glaucoma associated with uveitis. Moreover, it may be considered in the treatment of certain other diseases, e. g., corneal ulcers and corneal dystrophy, keratoconus, keratectasia, embolism of the central artery, hydrophthalmos and iris bombé. In a series of 54 cases in which more than 125 aspirations were performed, no complications occurred with the exception of 1 case in which there was a hemorrhage into the anterior chamber.

AN UNUSUAL CASE OF A RETAINED INTRAOCULAR METALLIC FOREIGN BODY. DR. EDGAR P. SHERMAN.

The patient was first examined by me on June 24, 1938, at which time he stated that for several months he had noticed that when reading or looking at objects he felt as if "there was a moving object or spot in front of his left eye." He recalled that about two years before a particle of coal dust blew in his left eye, and he attributed his complaints to that occurrence, although he did not seek medical attention or have any complaints at that time. He could not recall any other trauma. His general condition was excellent, and he had no other complaints.

Examination disclosed that the right eye was normal and the vision 20/20. The left eye was externally normal with no evidence of healed wound or scar. The cornea was clear. The anterior chamber, iris and pupil were normal. The lens and vitreous were clear. The fundus was normal except that the optic disk was practically obscured, being covered by a dark pigmented mass of essentially the same diameter as that of the optic disk. The mass protruded forward into the vitreous for approximately 6 mm. Within this mass and near its upper border there appeared a slightly darker mass about 1 mm. in size. The fundus was otherwise entirely normal. Vision was 20/30; with a slight astigmatic correction it was 20/20.

After noting this pathologic process, I reviewed the patient's history in detail. He finally recalled that eighteen years previous to the present complaint, while in the United States Marine Corps, he was breaking a box with a hatchet when he felt something strike his left eye. He wiped away a drop of blood, but, having no later complaints, he gave it no further thought. A roentgenogram showed the foreign body to be located in this mass on the optic disk. I was also able to obtain a photograph of the fundus which shows the metallic foreign body in its upper portion.

This is an interesting and unusual case because of the location of the foreign body and because it was covered by a dormant, black, exudative mass that, without a proper history and the benefit of a roentgenogram makes the ophthalmoscopic diagnosis difficult and could cause a divergence of opinion. It is also interesting because the corrected vision is normal and because in spite of the retention of a foreign body in the globe for eighteen years there is no siderosis or retinal changes. Apparently the exudative mass on the disk formed within a period of some weeks after the accident and, we can assume, ceased to progress, the mass remaining stationary throughout all these years.

We believe that no attempt should be made at removal, because if a magnet should dislodge this piece of metal there would without doubt be a certain amount of hemorrhage in the vitreous which would affect the vision if it failed to absorb, and it is possible that this procedure might be sufficient to stimulate this dormant mass and cause it to increase in size and thereby affect the vision.

BILATERAL CONGENITAL ECTOPIA LENTIS. DR. EDGAR P. SHERMAN.

A. B., aged 30, with bilateral congenital ectopia lentis, had an unimportant past history. Neither his parents nor his brothers or sisters have any condition similar to that presented by him. The bilateral congenital ectopia lentis and the slightly above average length of his arms, legs and fingers were the only true features of Marfan's syndrome evident. It is unusual that he has gone thirty years without an examination of his eyes, other than by an optometrist, until this year and was not aware of his condition.

Examination disclosed vision of 20/200 in each eye, although the patient favors the left eye for clearer vision for both distance and for reading. The anterior chamber in each eye was found to be slightly deeper than normal. The pupils were normal and equal, and each iris was normal. The vitreous was clear, and the fundi were normal.

Both pupils readily dilate under the influence of homatropine hydrobromide; it is then apparent that each lens is equally dislocated nasally and that the temporal edge of each lens is located practically in the center of each normal pupil. Under homatropine cycloplegia the vision of each eye can be improved with a cataract lens to approximately 20/40, but the patient cannot tolerate this correction when using both eyes.

Since the temporal edge of each lens lies in the pupillary area, he cannot use an aphakic correction and his vision cannot be improved for distance or for reading by what would be his normal refractive error. He actually prefers no correction. Incidentally, his reading distance is 5 to 6 inches.

The patient lacks some of the symptoms of Marfan's syndrome and presents others. If I am correct, the case is unusual only in one respect. The majority of such patients show unequal dislocation of the lenses or luxation into the vitreous, whereas the lenses of this patient are symmetrically and equally displaced nasally and will perhaps always remain so.

CONTRALATERAL TRANSILLUMINATION: A PRELIMINARY REPORT. DR. HENRY MINSKY.

A patient with a detachment of the retina anteriorly consulted me to confirm the advisability of an operation, recommended by another ophthalmologist. However, a small tumor of the ciliary body was diagnosed by contralateral transillumination and enucleation was advised. A third ophthalmologist agreed with the first until the technic of contralateral transillumination was demonstrated, whereupon he reversed his opinion and advised enucleation.

The patient consulted a fourth ophthalmologist, who treated her expectantly.

One and one-half years later she returned to the first physician, who enucleated the eye. Four years later she died after a hysterectomy, a malignant condition being present. She had wasted eighteen months.

The terms used for a new classification of the methods of transillumination consist of hyphenated words, the first part of which designates the point of contact of the illumination and the second, the portion of the eye examined. Latin roots are employed to render the system universal.

I wish to call particular attention to the method of contralateral transillumination whereby one side of the sclera is observed while the opposite side has the transilluminator applied to it with the eye in extreme rotation.

FURTHER STUDIES OF THE CANAL OF SCHLEMM AND ITS ANASTOMOSES (Presentation of Slides). DR. GEORGIANA DVORAK-THEOBALD, OAK PARK, ILL. (by invitation).

This paper will be published in a later issue of the ARCHIVES.

JAMES W. WHITE, M.D., *Chairman*

April 17, 1939

RUDOLF AEBLI, M.D., *Secretary*

A NEW IMPLANTATION SPHERE MADE OF VITALLIUM. DR. WILLIAM BROWN DOHERTY.

Many substances have been used for implants after enucleation. At the present time the most common implants are gold balls, glass balls, fat and fascia lata. None of these substances have been entirely satisfactory.

As metallurgic knowledge increases, particular alloys are developed for specific fields and in their applications exhibit advantages of superior properties not obtainable in the constituent metals of which they are composed. I wish to call attention to an alloy by the name of vitallium, a product of the Austenal Laboratories, Inc., the medical uses to which it has been applied and the clinical and scientific experimentation that has been performed with it. Vitallium has been used in prosthetic dentistry for a long period. Numerous experiments have been made with animals and also in the human body, and it has been found that vitallium produced no electrolytic action and remains completely inert in the tissue fluids.

Vitallium is a casting alloy 91 per cent of which is composed of cobalt and chromium with a smaller percentage of molybdenum; it is designated as a cobalt-chromium alloy. It is exceptionally strong, hard and very light. It has a specific gravity of 8.29, which is much less than the specific gravity of pure gold, which is 19.3, or of casting golds, which range from 14.0 to 19.0. This material resists strong mineral acids, and a solution of sodium chloride of any degree of concentration over any period produces no effect on it. Recently Drs. Dooley, Bergamini, Venable, Hopkins, Zuck and Smith-Petersen have reported unusual successes in the treatment of fractures with pins and plates of this material.

For the reasons already mentioned, I wish to present an implant made of this material and to call attention to the difference in weight between a vitallium implant and a gold implant. The vitallium implant is stronger than gold, cheaper than gold, can be boiled and lies inert in the body tissues.

DISCUSSION

DR. MARK J. SCHOENBERG: I should like to ask Dr. Doherty what is the longest time he has observed a patient with such an implant.

DR. WILLIAM BROWN DOHERTY: In my own case, five months, but vitallium has been retained in the human body for at least a year without any change.

POSTOPERATIVE REPORT IN A CASE OF MENINGIOMA PRODUCING UNILATERAL EXOPHTHALMOS. DR. JAMES W. SMITH.

This postoperative report will appear as an added note with a paper entitled "Meningioma Producing Unilateral Exophthalmos," which will be published in a later issue of the ARCHIVES.

THE ROLE OF STATES OF ANXIETY IN THE PATHOGENESIS OF PRIMARY GLAUCOMA. DR. MARK J. SCHOENBERG.

This article will appear in full, with discussion, in a later issue of the ARCHIVES.

Book Reviews

Principles and Practice of Ophthalmic Surgery. By Edmund B. Spaeth, M.D. Price, $12. Pp. 834, with 413 engravings and 4 colored plates. Philadelphia: Lea & Febiger, 1939.

After an introductory chapter on anesthesia, on the preparation of the patient and a description of usual instruments, the author takes up the subject of the orbit with a brief description of the pathologic picture and the clinical symptoms of the usual diseases with their operative treatment and the plastic repair of deformities. Then follows material on the lacrimal apparatus and operations for enucleation, for evisceration and for contracted socket. The ocular muscles are fully treated, with a description of the underlying clinical principles and indications for operation. The chapter on plastic surgery (pages 193-233) is a revision of the author's recent book on this subject. The chapter on the surgery of the lids (pages 234-418) gives a complete survey of the many operations which have been devised for the removal of tumors, for correction of deformities, trachomatous conditions and ptosis and for reconstruction of the lid. A useful chapter on important anatomic factors for operations on the eyeball precedes detailed descriptions of the surgical conditions met with in the conjunctiva, sclera, cornea and iris. The subject of keratoplasty is from the pen of R. Castroviejo. The chapter on cataract (pages 520-626) contains a description of the clinical variations and of the various operations in use and the later complications. The important subjects of glaucoma and retinal detachment are just as fully described. The book concludes with the localization of foreign bodies in the eye and their extraction and a short chapter on irradiation therapy.

The author has written a comprehensive textbook on ocular surgery, in 837 pages, with many quotations from recognized authorities and 1,031 figures and 4 colored plates which are taken from well known illustrations. The book is exhaustive in its scope and therefore may be bewildering to the beginner, but as a reference book for the experienced operator it can be recommended as presenting an up-to-date guide. The author is to be complimented on a painstaking piece of work; the bookmaking and illustrations are excellent.

ARNOLD KNAPP.

Pathologische Anatomie des Auges. By Prof. Wolfgang Stock. Pp. 244, with 415 illustrations. Stuttgart: Ferdinand Enke, 1939. Price, 24 marks.

As stated in the preface, Stock's monograph aims chiefly to serve students and practicing oculists. It is not meant to convey textbook information but to describe the histopathologic changes of the more common diseases of the eye.

The effects of inflammatory and degenerative diseases and tumors on the various structures of the eye are gone into with considerable detail in chapters on the lids, lacrimal apparatus, conjunctiva, cornea and

sclera, uvea, retina, optic nerve and orbit, and each is introduced by a brief description of the normal anatomy of the structure to which that chapter refers. There are also sections on the crystalline lens, glaucoma, the correlation between anatomy and refraction and, finally, injuries of the eye, including inflammatory sequelae.

This survey of the pathologic picture of ocular diseases contains no less than 415 carefully selected illustrations, for which the descriptive text is purposely short though comprehensive. It is here that the individual approach of the author is so well recognizable and the value of the book thus enhanced, as ophthalmology has been indebted for many years to Stock for his numerous valuable contributions to pathologic anatomy. It is fitting, then, that the chapters pertaining to his own investigations, such as diseases of the lacrimal apparatus, tuberculous inflammations, interstitial keratitis and pigmentary degeneration of the retina, are treated more thoroughly and are represented by an exceptionally fine collection of illustrations. Not only here but also in other parts unusual preparations are interspersed with those typical of the more common diseases of the eye. In the chapter on glaucoma, reference is made to lacuniform degeneration of the optic nerve, which the author has found also in myopia.

Following the aim of the book, discussion of controversial problems is avoided and certain complicated phenomena are simplified in order that the reader will not be confused.

This excellent collection of illustrations is done in black and white, and while in most cases the features to be emphasized are shown satisfactorily, in some particular reproductions the lack of color is regrettable, especially in a work designed for the use of students and physicians not familiar with the pathologic anatomy of the eye. However, this slight disadvantage does not essentially detract from the value and purpose of the monograph. Oculists will appreciate the part devoted to some of the interesting results of the author's own research work, which may prompt further study of the original articles.

L. SALLMANN.

Bulletin of the Ophthalmological Society of Egypt. Vol. XXXI. Thirty-Sixth Session, 1938. Pp. 118. Cairo: Imprimerie: Misr S. A. E., 1939.

The Ophthalmological Society of Egypt held its thirty-sixth annual congress under the presidency of Dr. Sayed Abdel Hamid Soliman Pasha on March 25-26, 1938, at the Memorial Ophthalmic Laboratory, Giza. Many interesting clinical papers were read, of which the following are to be noted: "How does Detachment of the Retina Begin?"; "Detachment of the Vitreous and Acute Hypotension in Detachment of the Retina" and "Weve's Diathermia Operation for Detachment." Dr. Max Meyerhof, speaking of irradiation treatment of sellar tumors, said that while in some cases irradiation may check the progress, in most cases operation is the only sure treatment. The volume ends with obituary notices of George E. de Schweinitz and Jean D. Démétriadis.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: Sept. 4-6, 1939.

Hungarian Ophthalmological Society

President: Prof. H. G. Ditroi, Szeged.
Assistant Secretary: Dr. Stephen de Grosz, University Eye Hospital, Maria ucca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

North of England Ophthalmological Society

President: Dr. A. MacRae, 6 Jesmond Rd., Newcastle-upon-Tyne, England.
Secretary: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the Secretary, Dr. Mohammed Khalil.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM

President: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Secretary: Mr. L. H. Savin, 7 Queen St., London, W. 1, England.

OPHTHALMOLOGY SOCIETY OF BOMBAY

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. Percival J. Hay, 350 Glossop Rd., Sheffield 10, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Time: July 4-6, 1940.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Malcolm Hepburn, 111 Harley St., London, W. 1, England.
Secretary: Dr. C. Dee Shapland, 15 Devonshire Pl., London, W. 1, England.

SOCIETÀ OFTALMOLOGICA ITALIANA

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome, Italy.
Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome, Italy.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

TEL AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.
Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: New York. Time: June 10-14, 1940.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Chicago. Time: Oct. 8-13, 1939.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick Tooke, 1482 Mountain St., Montreal, Canada.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: Hot Springs, Va.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Secretary-Treasurer: Dr. C. S. O'Brien, University Hospital, Iowa City.

Canadian Medical Association, Section on Ophthalmology

President: Dr. S. Hanford McKee, 1528 Crescent St., Montreal.
Secretary-Treasurer: Dr. J. A. MacMillan, 1410 Stanley St., Montreal.

National Society for the Prevention of Blindness

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. Andrew Rados, 31 Lincoln Park, Newark.
Secretary: Dr. William F. McKim, 317 Roseville Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. R. O. Ebert, 104 Main St., Oshkosh.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

New England Ophthalmological Society

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. Trygve Gundersen, 243 Charles St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

Pacific Coast Oto-Ophthalmological Society

President: Dr. F. C. Cordes, 384 Post St., San Francisco.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

Puget Sound Academy of Ophthalmology and Oto-Laryngology

President: Dr. J. Edward Clark, 1305–14th Ave., Seattle.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

Rock River Valley Eye, Ear, Nose and Throat Society

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501–7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

Saginaw Valley Academy of Ophthalmology and Otolaryngology

President: Dr. Don M. Howell, Alma, Mich.
Secretary-Treasurer: Dr. Louis D. Gomon, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

Sioux Valley Eye and Ear Academy

President: Dr. R. A. Kelly, 304 N. Main St., Mitchell, S. D.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

Southern Medical Association, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. Dake Biddle, 123 S. Stone Ave., Tucson, Ariz.
Secretary: Dr. M. P. Spearman, 1001 First National Bank Bldg., El Paso, Texas.
Place: El Paso, Texas. Time: Nov. 9-11, 1939.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. Carl Wencke, Battle Creek.
Secretary-Treasurer: Dr. A. K. Zinn, Battle Creek.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, 41 N. Brady St., DuBois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Virgil Payne, Pine Bluff.
Secretary-Treasurer: Dr. Raymond C. Cook, 1005 Donaghey Bldg., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. Melville Black, 424 Metropolitan Bldg., Denver.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. Shirley H. Baron, 309 State St., New London.
Secretary-Treasurer: Dr. S. J. Silverberg, 201 Park St., New Haven.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: Dr. Grady E. Clay, 384 Peachtree St. N. E., Atlanta.
Secretary-Treasurer: Dr. J. Mason Baird, 511 Medical Arts Bldg., Atlanta.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. D. C. Montgomery, 301 Washington Ave., Greenville, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. B. Fralick, 201 S. Main St., Ann Arbor.
Secretary: Dr. O. McGillicuddy, 124 W. Allegan St., Lansing.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Frank N. Knapp, 318 W. Superior St., Duluth.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY

Chairman: Dr. James S. Shipman, 542 Cooper St., Camden.
Secretary: Dr. Wright McMillan, 23 Passaic Ave., Passaic.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

Chairman: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Secretary: Dr. Chester C. Cott, 333 Linwood Ave., Buffalo.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. F. C. Smith, 106 W. 7th St., Charlotte.
Secretary-Treasurer: Dr. M. R. Gibson, Professional Bldg., Raleigh.
Place: Statesville: Time: Sept. 21, 1939.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. N. A. Youngs, 322 De Mers Ave., Grand Forks.
Secretary-Treasurer: Dr. F. L. Wicks, 516–6th St., Valley City.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. L. O. Clement, 406 State St., Salem.
Secretary-Treasurer: Dr. Paul Bailey, 833 S. W. 11th Ave., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. S. B. Fishburne, 1430 Marion St., Columbia.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. B. Stanford, 899 Madison Ave., Memphis.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. A. N. Champion, 705 E. Houston St., San Antonio.
Secretary: Dr. Dan Brannin, 1719 Pacific Ave., Dallas.
Place: Houston. Time: December 1939.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.
Secretary-Treasurer: Dr. M. H. Williams, 30½ Franklin Rd. S. W., Roanoke.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron, Ohio.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. Arthur G. Fort, 478 Peachtree St. N. E., Atlanta, Ga.
Secretary: Dr. Lester A. Brown, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., second Wednesday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Secretary: Dr. Fred M. Reese, 6 E. Eager St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. N. E. Miles, 408 Medical Arts Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. E. Clifford Place, 59 Livingston St., Brooklyn.
Secretary-Treasurer: Dr. Frank Mallon, 1135 Park Pl., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. James G. Fowler, 412 Linwood Ave., Buffalo.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park, Ill.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Ophthalmologic Club

Chairman: Dr. Albert J. Ruedemann, Cleveland Clinic, Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Clerk: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. Hugh G. Beatty, 150 E. Broad St., Columbus, Ohio.
Secretary-Treasurer: Dr. W. A. Stoutenborough, 21 E. State St., Columbus, Ohio.
Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Maxwell Thomas, Medical Arts Bldg., Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Dr. Arthur S. Hale, 1609 Eaton Tower, Detroit.
Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. L. A. Hulsebosch, 191 Glen St., Glen Falls.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. A. Gough, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 806 Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Louis Daily, 1215 Walker Ave., Houston, Texas.
Secretary: Dr. Herbert H. Harris, 1004 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to June.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. E. N. Robertson, Concordia, Kan.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Secretary-Treasurer: Dr. Paul Nilsson, 211 Cherry Ave., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. Gaylord C. Hall, Brown Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Charles K. Beck, Starks Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Earle Breeding, 1801 I St. N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606–20th St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

Milwaukee Oto-Ophthalmic Society

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Minneapolis Ophthalmological Society

Chairman: Each member, in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. L. de G. Joubert, 690 Dunlop St., Montreal, Canada.
Secretary: Dr. K. B. Johnston, 1509 Sherbrooke St. W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Haven Ophthalmological Society

President: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Secretary: Dr. Frederick A. Wies, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. E. G. Walls, 619 Maison Blanche Bldg., New Orleans.
Secretary-Treasurer: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Percy Fridenberg, 38 W. 59th St., New York.
Secretary: Dr. David Alperin, 889 Park Pl., Brooklyn.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. J. T. Maxwell, 1140 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Ophthalmological Society of the University of Pittsburgh

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

Passaic-Bergen Ophthalmological Club

President: Dr. R. N. Berke, 430 Union St., Hackensack, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Walter I. Lillie, 255 S. 17th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Edward Stieren, Union Trust Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Rudolph Thomason, Professional Bldg., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Edwin S. Ingersoll, 26 S. Goodman St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.
Place: Rochester Academy of Medicine, 1441 East Ave. Time: 8 p. m., second Wednesday of each month from September to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. B. Y. Alvis, Carleton Bldg., St. Louis.
Secretary: Dr. Carl C. Beisbarth, 3720 Washington Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. R. Kirkpatrick, 6th and Walnut Sts., Texarkana, Ark.
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. P. B. Greene, 422 Riverside Ave., Spokane, Wash.
Secretary: Dr. O. M. Rott, 421 Riverside Ave., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. James F. Cahill, 428 S. Salina St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. A. Lloyd Morgan, 170 St. George St., Toronto, Canada.
Secretary: Dr. W. R. F. Luke, 170 St. George St., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. Ernest Sheppard, 927 Farragut Sq. N. W., Washington, D. C.
Secretary-Treasurer: Dr. E. Leonard Goodman, 1801 I St. N. W., Washington, D. C.
Place: Episcopal Eye and Ear Hospital. Time: 7:30 p. m., first Monday in November, January, March and April.